Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

NOVEMBER, 1911.

THE NEW ASTRONOMY.

III.—STAR CLUSTERS AND NEBULAE.

By PROFESSOR A. W. BICKERTON.

With illustrations from photographs by G. W. Ritchey.

IT seems strange that astronomy, with all the marvels revealed by the modern methods, has not a greater hold on the human mind. But doubtless the wondrous beauty of the heavens appeals far more to a shepherd folk, with their ample night leisure, their clear sky, their serene minds, than to city people. The brilliantly lighted streets of London outshine even Sirius or the brightest comet. I have seen the moon herself showing over the house tops as a feeble kind of large artificial light. In a big city, music hall stars are far more effectively attractive than a shining star cluster or even the whole galaxy of the heavens. Astronomy too, has become somewhat dry and arid. Official astronomers do not care for theories, for the linking silken cords of correllation, that will weave together their wonderful isolated threads of facts and convert them into the shimmering fabric of a beautiful and consistent scheme of creation so grand and glorious as to be capable of giving hope and energy to human thought, and high purpose to human aims. Nevertheless the neglected celestial vault is the stage of much romance and beauty. The moon under a telescope of moderate power is an exquisite object, and so is the crescent of Venus, the ringed planet Saturn, or the spiral nebulae. But perhaps, as I said in *Harper's Magazine*, September number, imagination is wanted: "Were we to picture time as passing so swiftly that centuries were as seconds, to the eye of the mind we should see the star clusters appearing as moving masses of many-hued fireflies, the planets as rings of silver light, and we should see the whole stellar heavens astir as a swarm of shining bees." No imagination seems to be required when star clusters are seen through giant telescopes, they appear to eclipse everything else for brilliant magnificence.

THE WONDER AND BEAUTY OF STAR CLUSTERS.

These groups of celestial gems may sparkle like diamonds of the first water, or they may shine with many a varied tint, some blue beyond the Oriental sapphire, some vivid green, or red, or purple. Some of the groups are all white; some, as in the constellation of the Southern Cross, are white, interspersed with red, blue, and green stars; while the most wonderful of all the clusters, that in the Toucan, is of an exquisite rose tint. Then the number of component stars is wonderful; in most clusters they may be counted by hundreds, in some there are many thousand independent points of light, every point of light a sun perchance bearing a planetary system with it. What possibilities unfold themselves. Think of any one of those solar systems threading its way through the maze of the other suns. What vicissitudes it must encounter. For hundreds of years it might revolve amongst the densities at the centre of the system; then its orbit might be deflected and for thousands of years it might travel towards the exterior of the cluster. With the sudden effect of natural selection, on the satellites of such a sun, the changes from tropic to arctic during the great glacial epochs of the earth would hardly compare. Then, again, how the heavens must alter in aspect within those wondrous coloured clusters, where in one part the emerald and the

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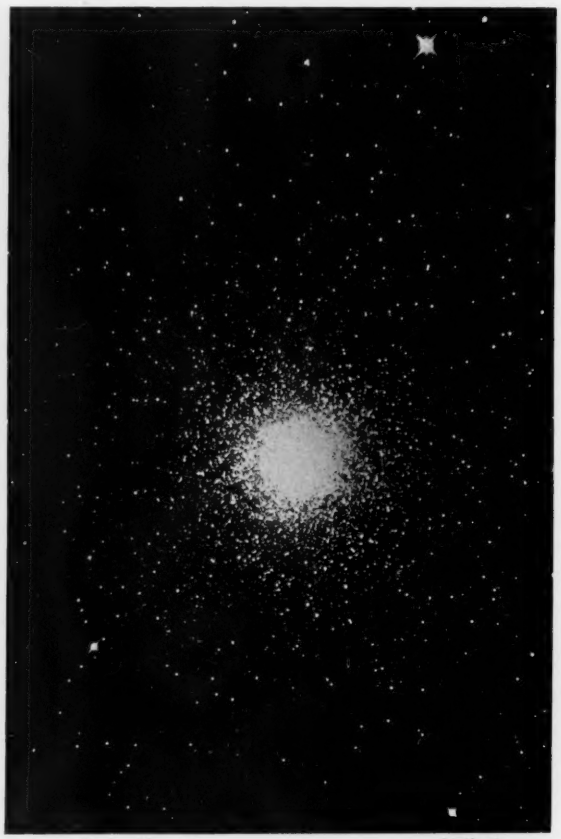
ruby enhance their mutual beauty, and in another the topaz and the sapphire outglow each other. Imagine oneself the inhabitant of a planet lit by a ruby sun and an emerald sun. Consider the brilliant pictures and the shadows, every shadow double, one coloured red and the other green. These wonders seem too much for full description. So I will not try to describe the effects as seen by the inhabitants of planets within a coloured star cluster; I leave it to the readers of "KNOWLEDGE" to imagine the scenery for themselves.



Taken at Yerkes Observatory *April 9th, 1910.*

FIGURE 1. Star Cluster M.3. Canes Venatici.

A typical star cluster with a condensed centre; a more diffused one, that of ω Centauri, was shown on page 343 of the September issue.

COLLISIONS IN CLUSTERS.

The great Humboldt asked this most suggestive question: "How can these systems be maintained—how can the suns, crowding at the interior of star clusters, fulfil their revolutions freely and without clashing." Do they revolve without clashing? The answer is: Almost certainly they occasionally clash.

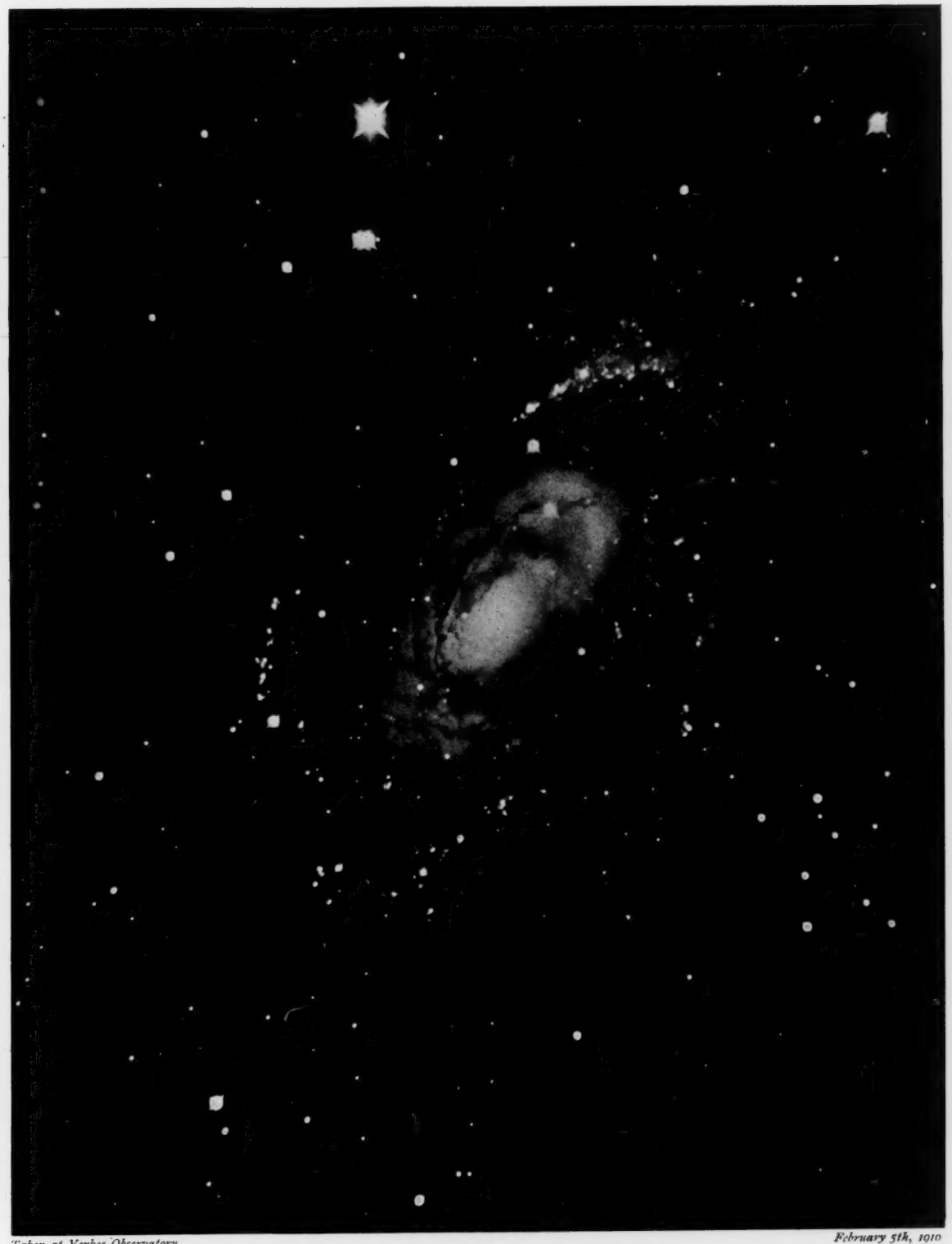
Novae sometimes occur in star clusters as do many variables. We have already proved that the impact of suns absolutely must produce new stars, and Nature seems to offer no other suggestion of their origin. Every such impact must strew the space about the point of collision with meteoric and gaseous matter, which must exercise a retarding effect upon the suns passing through it, and produce other impacts strewing variable stars over the cluster. Every such collision lessens the motive energy of the cluster, and helps to weld it together, until finally, after eons have passed, a vast nebulous sun may result.

THE GENESIS OF CLUSTERS.

How do star clusters originate? Possibly they are the nuclei of vast third bodies that have been struck from gigantic suns, or perhaps the result of whirling coalescence, where great angular motion prevented condensation to a centre. We have already seen that selective molecular escape must rob the bodies at unstable temperatures of their light gases, whilst a vast expanding rotating mass of elements of greater atomic weight will be left behind, that is a rotating meteoric swarm. Such a rotating mass will not quickly tend to concentrate to a centre, the angular velocity will keep the particles in orbits. These orbits must be continually crossing one another, and although the general rotation of the mass will be in one direction, as the swarm will be roughly spherical, the individual particles will be in orbits in all azimuths. Hence, instead of concentrating to a plane as they would probably do were they subject to a great central controlling force, they will tend to aggregate into larger and larger fragments, the whole retaining somewhat of a globular form. Small swarms of this character would probably give rise to some of the comets, but it would not be the only method of their formation, as impact shows us, many modes by which dust swarms may originate. Very gigantic swarms would, as the ages rolled on by continued coalescence gradually form star clusters in which the constituent suns would be somewhat similar in mass.

Impacts within star clusters would not be so liable to produce double stars as under ordinary circumstances, because in proportion to the mass there must be a very considerable orbital proper motion. Hence, although we should expect a fair number of very transitory novae and a great number of variables in special parts of star clusters, or in special clusters, we should not expect a great number of double stars. The whole subject of the internal motions of star clusters is one worthy of very careful study on the part of the astronomer. We shall require to know much more than we do about these motions, before there can be any certainty as to the origin of clusters.

The suggestion here made as to their genesis has considerable elements of probability, but is certainly not an absolutely demonstrated deduction, as is the partial impact origin of new stars by the formation of the third body. Nor does it compare in



Taken at Yerkes Observatory *February 5th, 1910*

FIGURE 2. Spiral Nebula M.81. Ursae Majoris.

Probably a case of whirling coalescence of two globular nebulae of about equal volume and mass.

probability with the impact origin of variable and double stars; in both of which cases the evidence is so conclusive that it is certain that a very large number of the wonder and double stars of the heavens did actually originate from the grazing impact of suns.

PLANETARY NEBULAE.

There is very strong evidence, indeed, that most, if not the whole of the so-called planetary nebulae, originated from the impact of suns. It is almost certain that Herschel's wonderful suggestion as to the physical character of these bodies is true. He examined these circular discs of faint even light with great care and he tells us that only one possible suggestion of their character offers itself. They cannot really be discs, or they would sometimes be shown to us more or less edge on; they cannot be continuous spheres of gas, or the edges would be much less brilliant than the central portions. The only explanation left, inconceivable as it may seem, is that they are hollow shells of gas. How such bodies could be formed appeared to him a mystery, but it is obviously a clear and simple deduction, when we study the properties of the third body and apply to it the principle of atom sorting.

FIGURE 3. Webb's Nebula.
Diagram showing by the continuous spectrum the meteoric nuclei within the ensphering shells.

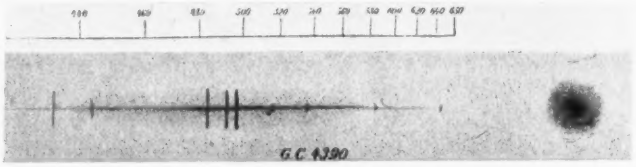


FIGURE 4. Struve's Nebula.
Diagram showing in spectrogram that concentric layers are of different elements.

THE ORIGIN OF PLANETARY NEBULAE.

We have already shown that the high kinetol of the light gases, must under many and varied circumstances cause such elements as helium, hydrogen, nebulium, and so on, to leave systems. We have also seen that on the birth of the third body, the atmospheres of the suns must be at the centre of the mass. and as expansion occurs these light gases gradually make their way out. By taking energy from heavier elements these light atoms attain an escaping velocity. It is clear that this inversion of the position of the elements could not occur suddenly. At the birth of the third body, the light elements do not move faster than the heavier ones. This increase of speed is obtained as the temperatures tend to become equal, consequently much of the later escaping hydrogen will not possess anything like the speed that some of the light material, better situated, will attain, and hence some of it may only have a velocity approximately that of the critical velocity. The whole third body is rotating, and hence particles with slightly less than the critical velocity will be carried to enormous distances, and will not tend to concentrate back again, because the rotation will give them an orbital power.

In every stage of atom sorting there will tend to be ensphering shells, in which the lighter gases will be the outer ones, and consequently many of the planetary nebulae will have a sphere in sphere structure.

THE CENTRE OF THE PLANETARY NEBULAE:

They should also often have centres consisting of material of greater density. Sometimes this centre would be a rare meteoric swarm, such as seems to be the case with Struve's and Webb's planetary nebulae. Both of these nebulae, as shown by Keeler's drawings, exhibit also the sphere in sphere structure. (Figures 3 and 4.) Sometimes the meteoric swarm would be dense enough to appear stellar, perhaps with a velvety structure. Some of the planetary nebulae actually do exhibit such a star. In some cases the two suns would be entrapped into a double star the distance of whose constituents from one another might be very small compared with the dimensions of the planetary nebula, for some of these extraordinary bodies have dimensions that are inconceivably stupendous. The orbit of the earth would be as a child's hoop in a continent, compared with the vast dimensions of some of these celestial shells of luminous gas.

I think it extremely probable that every planetary nebula is gas that has been produced by an impact of suns, gas that has sorted itself, by selective escape, into a condition of practical stability. The planetary nebulae that are known to result as the final stage of many temporary stars need not necessarily be permanent shells; the speed may be so great that the material may be carried on into distant space, or not great enough to form permanent gas shells. The width of the lines in the spectrograms would tell much as to this velocity.

The same remark applies to planetary nebulae as was made regarding star clusters. Their character and motions should be studied in the light of the new astronomy of impact, to ascertain how far they tend to give solidity to this new theory, or to modify some of its conclusions.

WHITE NEBULAE.

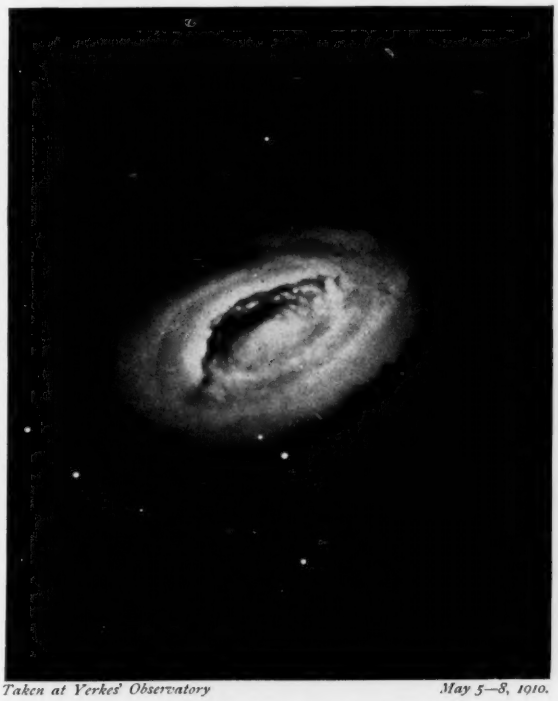
Covering vast regions at the two poles of the

Galactic circle are hundreds of thousands of nebulae. An immense number of them are of an exquisite double spiral structure. In the next article, in describing the origin of the Galaxy, we shall attempt to show that these nebulae were extruded during the coalescence of the two cosmic systems which this theory suggests went to the formation of the system of stars that is commonly known as the Universe. It will be explained that the Milky Way is the result of what we have called "Whirling Coalescence," and that the two great sheets of nebulous matter that now clothe the two poles of the Galaxy were ejected during the earlier periods of coalescence by the agency we have named "Axial extrusion." In studying, then, the origin of these double spiral and other white nebulae, we have to assume that the two poles of the Galaxy were at one time covered with vast continuous sheets of nebulous matter which the action of "selective molecular escape" had largely robbed of its light gases. Into such a sheet of material, the many errant masses that are sent out of systems by the agencies described in "The Birth of Worlds and Systems" would penetrate, and would gradually be volatilised by friction, and would form cometic nebulae, developing into roughly globular nebulous condensations. These portions would be denser than the general sheet of nebulae. Any condensed masses that were near one another would

Taken at Yerkes' Observatory *February 7—8, 1910.*

FIGURE 5. Spiral Nebula, Canes Venatici.

A probable case of oblique impact between two nebulae of extremely different volumes. A considerable portion of the large nebula remains at the end of the spiral.



Taken at Yerkes' Observatory *May 5—8, 1910.*

FIGURE 6. Spiral Nebula, M.64. Comae Beren.

A probable case of whirling coalescence of two previously existing nebulae.

be influenced by mutual attraction, and approach one another. Lateral attraction of other nebulae would, as a rule, prevent direct impact, and hence the approaching pair would move in curved orbits and come into grazing impact. This graze may, of course, be of any depth, as already suggested in the case of grazing suns.

THE EFFECTS OF DEPTHS OF GRAZE.

The mere margins may collide and, as they do so, the impact would greatly increase the temperature, and hence the luminosity, of the colliding margin, and then, after a long period, a streak of light would exist between a pair of more or less globular nebulae—a condition that not infrequently shows itself in connection with double nebulae. In certain positions we should obviously have a nebula somewhat of a dumb-bell shape.

If the graze be deeper, we should have a vast spindle-shaped nebula produced as a third body, only, unlike that of the suns, it would be of extreme tenuity. But the kinematics of the two are the same and hence rotation will ensue, and a spiral begin to show itself in the centre of such nebulae. We know of many examples of this, that of Leo being very beautiful. As time rolled on such an incipient spiral would complete itself, and we should have a double spiral structure. Such a definite structure as this would not be possible in the case of the grazing impact of dense bodies like suns,

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because the explosion of the third body would be of such thermodynamic intensity as to blow the spiral to pieces.

WHIRLING COALESCENCE OF NEBULAE.

Again, imagine that the globular nebulae strike so deeply as to give us cases of whirling coalescence. On the grounds of both deduction and observation, this would seem to be the general case of nebular collisions. When we look at the kinetics of this special class of impact, this deduction is very strongly supported. Let us examine such a case of the coalescent collision of globular nebulae. The pair have penetrated deeply the one into the other, the portions outside the range of actual collision would be carried forward by their own momentum, but would be subjected to the attraction of the vast third body produced by actual collision. The capturing power of the third body would curve these portions into a double spiral. The middle portion would, however, be so intensely heated that a good deal of it would be expelled both by selective molecular escape, and by axial extrusion. Consequently the attraction would weaken, permitting centrifugal force to act and allowing the two great tongues of fire to proceed outward, as two giant arms of an immense double spiral nebula.

Taken at Yerkes Observatory *March 6—7, 1910.*

FIGURE 7. Nebula, H.V.24. Comae Beren.

Probably a high velocity case of whirling coalescence, in which the outer parts that have not come into collision still remain as non-luminous dust, and so obstruct the light of the spiral.

AGENTS MODIFYING THE SPIRAL.

All kinds of modifications of the form of this double spiral may be due to differences of size, or difference of density, of the impacting nebulae. One or both of the two colliding masses may already be made up of more than one centre of condensation. In this way the two arms may differ so much in volume from one another, that it may form a vast almost independent nebula at the end of one of the arms; such as we see so strikingly in the great nebula in Canes Venatici, (Figure 5).

In the case of previous rotation, the original motion would give great irregularity to the arms of the spiral, and even tend to give it a multiple appearance. Of this resultant motion we have very many examples. Hence it seems that we have but to study the kinetics and kinematics of the various impacts of nebulae, and every element of mystery in the origin of their form and structure disappears. When we take into account differences of density, differences of volume, differences of depths of encounter, differences in the stage of impact, there is possibly no single form amongst the hundreds of thousands of those photographed, but we have a clear dynamical account of their evolution. Thus we are presented with a set of principles that absolutely explain the origin of each and every one of these exquisite celestial flowers, the glowing nebulae that we find in every stage of bloom in the celestial fields.

In our next article we shall attempt to show that by applying the same reasoning, as here given to nebulae, to the impacts of systems similar to the great clouds of Magellan, the mystery surrounding the birth of the grand Galactic system we call the visible universe is in like manner completely dissipated, and the whole cycle of the eternal heavens is revealed to our mental gaze.

FOURIER'S SERIES IN THE "ENCYCLOPAEDIA BRITANNICA."

To those with a taste for mathematics here is fine food. Fourier's invention of the series bearing his name formed a landmark in Mathematical Science at the beginning of last century. He shewed by their means that it was possible under certain circumstances to represent any discontinuous or arbitrary valued function by an even series.

Interest is added to the study of these by knowing that they have considerable application in physical science, especially in the theory of heat.

The article in the Encyclopaedia treats the subject very ably and explicitly, and gives a few well-chosen simple graphical examples.

Preceding the article on Fourier's Mathematical work is one giving a short history of his political life, from which we learn that Fourier, in addition to belonging to the company of illustrious men of science that France has given to the world, also achieved uncommon success as a politician.

T. W. K. C.

PSYCHICAL RESEARCH.

By J. ARTHUR HILL.

IT is related of Mme. de Staël that she did not believe in ghosts, but that she was afraid of them all the same—"*je ne les crois pas, mais je les crains.*" The witty Frenchwoman's epigram contains deep psychological truth; for our emotions are not ruled by our reasoned beliefs. And, in addition to its true psychology, it accurately describes the attitude of the average man, though he may not confess it so frankly. We don't believe in ghosts—oh, no, not really *believe* in them. But we are at times a little—just a little—afraid of them; say, for instance, when going to bed at two in the morning (at which hour, according to Napoleon, courage is at its lowest ebb) up the gloomy staircases and in the draughty corridors of an old and lonely house, with the wind soughing and sobbing and wailing in the trees outside—like the wraith of poor Cathy in "Wuthering Heights." At such times, we have inner qualms, step we never so boldly.

The recent advance in certain by-paths of science, however, seems likely to go far towards effecting a change in popular opinion and popular feeling. The ghosts, like everything else in this extremely scientific age, are now being studied and examined, and photographed and dissected (or would be, if they had any insides to dissect), and the prospects are that before very long, we may get so well acquainted with these *animulae vagulae* that we shall no longer be afraid of them. Then we shall be able to reverse the epigram; instead of disbelieving yet fearing, we shall believe but shall not fear. This consummation may be displeasing to the orthodox haunting ghost, whose business is (like the Fat Boy's in "Pickwick)," to make our flesh creep; but, on the other hand, it will meet with the approval of all sensible and well-disposed spirits, such—for example—as Mr. Stead's friend Julia, of whom we have lately been hearing so much.

The "spirit" question, however, is the wrong end of the subject to attack. Of course, when an apparition does turn up it is the percipient's scientific duty (if he can keep his wits about him sufficiently to do it well) to observe it, to make careful notes at once, and to get them signed—along with a doctor's certificate of sobriety—by corroborating friends. Then, if the person represented by the spook is afterwards found to have died at the time of the vision, we have good evidence for some kind of supernormal agency. Or if—as is most likely—he did not die; if, indeed, he was in specially good health and spirits at the time; if, in short, our hallucination was due to indigestion (as the doctor probably assured us), we naturally feel a mild regret that the Society for Psychical Research should have lost a promising "case," but, on the other hand, we have at least retained our friend, who—perhaps equally naturally—will be apt to regard our aforementioned regret with a feeling akin to resentment. But, even in cases of veridical hallucination—*i.e.*, hallucinations which seem somehow connected with distantly-occurring events, and which are therefore "truth-telling"—even in these cases, the scientific value of the phenomenon itself is perhaps less than that of many apparently less important happenings. For it is not the mere establishing of the actuality of an alleged phenomenon, that constitutes its value to pure science. It is the linking of it up with facts already known; the fitting of it into the mosaic of already organized knowledge; the bringing of it into the domain of law;—it is here that the main business and interest of the philosophical scientific man are to be found. And, in the case of ghosts, this linking up, and fitting in, does not seem likely to be an easy matter, even if the facts are satisfactorily established.

It was therefore with deep wisdom that Sir Oliver Lodge, in "The Survival of Man," which is the latest important pronouncement on the subject, decided to begin at the other end. Instead of plunging into the description of phenomena which puzzle us because they seem so out of relation with our scientific knowledge, he starts by giving a lengthy and careful description of some experiments of his own which seem to establish the fact of thought-transference or "telepathy." In these very matter-of-fact and unghostly experiments, the chief parts were played by two young ladies who were employed by a Liverpool firm, of which Mr. Malcolm Guthrie, J.P., was head. One of them—the receiver or "percipient"—was blindfolded, though as an aid to passivity of mind rather than as a precaution. The other—the "agent"—concentrated her mind on an object selected by Sir Oliver, trying to impress the idea of it on the mind of her friend. Care was taken, of course, that the latter was afforded no opportunity of seeing the object, or of gleaning any information of its nature by normal means. Many of the experiments were made with ordinary playing cards; for, by this means, the likelihood of chance coincidence could be mathematically determined. In one series which Sir Oliver quotes, the successes were ten out of sixteen. The chance of this occurring by accident can be shown to be less than one in ten million.

From this we go on to telepathy at a distance. Recent experiments between Miss Miles and Miss Ramsden, carried out in accordance with suggestions made by Professor Barrett, indicated clearly that

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some supernormal agency was at work. The distance between the experimenters varied, as one of them was travelling about; during part of the time it was about four hundred miles. Often, the exact idea sent by the agent was received by the percipient, who sat alone, at a specified hour, waiting passively for ideas to drift into her mind. At other times, the message received was not that which had been consciously sent, but nevertheless represented something which had been occupying the agent's mind during the day. From this it appears that the agent's subconsciousness, as well as the ordinary conscious level of the mind, may have something to do with the process.

With this in mind, we go on to consider a different class of phenomena, *viz.*, what is called by spiritualists "trance-mediumship," and by psychical researchers "motor automatism with obscuration of the supraliminal consciousness," or other terms to that effect.

It is a common thing for a sitter with a trance medium to be told the most astonishingly correct and intimate details of his family life, the names of his relatives, and so on, although, so far as he knows, he is an entire stranger to the medium. The intelligence, or control, purports to be a guardian-angel sort of spirit, who habitually speaks through this medium, and who says that he or she is getting the information from spirits who are the sitter's deceased friends or relatives. Sometimes one of these latter is allowed by the "guardian-angel spirit" to take personal possession of the medium's body, and thus to speak directly. In such a case the astonished sitter (*i.e.* if he is a novice) finds himself addressed in characteristic fashion by some dead person, reminded of little experiences which they had shared in life, and is perhaps ultimately convinced that he is veritably in direct communion with the disembodied mind of his relative or friend. When the medium wakes up, she (it is usually a "she") has absolutely no knowledge of what her vocal organs have been saying.

Now how are we to set about explaining all this?

The first thing to make sure of is, of course, that ordinary fraud is excluded. This is usually a fairly easy matter. When the sitter can question the "spirit" (as in these cases he always can) it is easy enough to get satisfactory assurance that common trickery is not the correct explanation; for questions can be asked concerning family matters, or mutual experiences, of which the medium could not be normally aware, even assuming the employment of skilful and energetic detectives. Moreover, in several cases known to me, the sitter gave either a false name, or no name at all. In one of these cases, the sitter was a friend of mine, living two hundred miles from London, where the sittings took place, and there is no reason to suppose that he was in the least degree known to the medium. He was not a spiritualist, had no spiritualistic friends, and had never sat with a medium before. Yet the guardian or "guide" gave my friend's two Christian names, with a good deal of true detail about his life, and at the second sitting, two days later, he was greeted by an intelligence purporting to be his recently-deceased mother, who alluded by name to all the near surviving relatives, with appropriate comment and attitude, and gave other evidence of a characteristic and convincing nature. My friend had gone into that room a sceptic, bent on "showing up" these tricky mediums; he came out absolutely convinced that he had spoken with his deceased mother. I express no opinion, except that some supernormal explanation seems to be required. (I may also remark that this case, considered in full detail, is much more evidential than this necessarily short description can indicate. It is described in full in my just-published book, "New Evidences in Psychical Research." (William Rider & Son, Ltd. 3s. 6d.)

Fraud being excluded, we turn to other possible theories; and, bearing in mind the fact of thought-transference or "telepathy"—already established by experimental methods—we surmise that the medium has somehow read the sitter's thoughts. The fact that the trance-control's remarks do not coincide with what we were thinking of at the time, is no obstacle, for, as we saw in the case of Miss Ramsden, it is not always the agent's *conscious* thought that is reproduced. The medium's trance-consciousness may be able to rummage among our memories, selecting those which stick together round a given personality. As to the verisimilitude of the characterisation, this is easily comprehensible; for it is a well-known and continually-observed fact that in the hypnotic state many subjects are excellent mimics, and hypnosis is undoubtedly related to "mediumistic" trance.

It follows, then, that nothing more than thought-transference need be supposed, so long as the medium tells us nothing except what we already know. But what shall we say if things are told us—things characteristic of the *soi-disant* spirit—which have never been known to us, but which on investigation turn out to be true? Well, this certainly complicates matters, but, knowing that telepathy can be effected over great distances, as in Miss Miles' and Miss Ramsden's experiments, we are able to suppose that the fact in question has been somehow telepathically gleaned from some distant mind. It is, however, clear that in making this supposition we are treating two cases as analogous, which differ in important features. Miss Miles and Miss Ramsden are well known to each other, are, in fact, friends: and, though the consciously-attempted message sometimes failed, another (which was not "sent") taking its place, it must nevertheless be borne in mind that the two experimenters were thinking of each other frequently, and that there was thus a certain *rapport* between them. Whereas, in some of these trance

messages, the person whose mind must be supposed to have supplied the information is a person who has never seen the medium; is not known by the medium; is unaware of a sitting being in progress, and therefore is not thinking of anything of the kind; is indeed perhaps unaware of the medium's existence, and hostile to psychical research and all its works. The conditions are therefore very different from those of experimental thought-transference. Still, this latter fact having been established, and its possible range not yet being satisfactorily defined, we are bound by the law of parsimony to work telepathy for all it is worth, before turning to other and more far-fetched-seeming hypotheses. So long, therefore, as any living mind contains a fact which is retailed by a control as evidence of its identity, we must suppose that it may be a case of telepathy from that living mind.

I say we must suppose that it *may* be. It does not by any means follow that it *is*. Some of the cases quoted by Sir Oliver Lodge as occurring in his own experience with Mrs. Piper, though possibly explicable by telepathy, are nevertheless strongly suggestive of the action of a disembodied intelligence. For example, a "spirit-communicator" in Mrs. Piper's trance claimed to be the deceased son of Mr. Rich, the then Postmaster at Liverpool. This entity wished a message to be sent to his father, who was said to be worrying specially about his son's death. The sitters knew Mr. Rich slightly, but knew nothing about the matter dealt with in the message. This latter, however, was duly delivered, and turned out to be appropriate to, and characteristic of, the deceased young man. The exceptional worry or grief was due to a slight estrangement, which would have been only temporary. If we are to invoke telepathy in this case (and it is only one of many similar ones) we are driven to the curious supposition that Mr. Rich subconsciously sent a telepathic message to Mrs. Piper (whom he did not know, and who did not know him) and that this message was dramatized and returned. In other words, that he sent a deceptive message to himself—*via* Mrs. Piper, and by means unknown to science—without knowing anything at all about it! It seems almost as easy to believe in the *primâ facie* explanation (*i.e.* genuine spirit communication) as in such marvellous telepathic exploits as this.

But is there—it may be asked—any way of putting it to the proof? Cannot telepathy be shut out, somehow? Cannot crucial tests be devised? On this very important point several acute brains have been cudgelling themselves for many years.

It was at one time thought that the best test would be the posthumous reading—through a mediumistic communication—of a sealed letter left in the keeping of a friend. Such a letter was left with Sir Oliver Lodge by Mr. Myers; but the attempt by a *soi-disant* Myers-communicator to give, through Mrs. Verrall's automatic writing, a reproduction of its contents, was a complete failure. It is now recognized that the test is not a good one; for, even if it succeeded, it would not yield proof. It would still be possible to suppose that the deceased had, before dying, unconsciously "telepathed" the contents of his letter to some person or other, and that, when a medium somewhere produced the message correctly, it was through telepathy from the subconsciousness of this hypothetical person. Or, again, the letter, though sealed, might be read "clairvoyantly." Some such power is often alleged, and there is a good deal of evidence in its support. Further, is it not too much to expect that a spirit will remember what the letter contains? Sir Oliver Lodge has not prepared such a letter, for he is quite sure that he would forget what he had written. Probably most people will feel similar doubts about their *post-mortem* recollection of such matters.

The sealed-letter test, then, is given up as unsatisfactory. What shall we turn to next?

It was thought by Mr. Myers and Professor Sidgwick that it would be rather good evidence if the same message could be obtained from the same spirit through two or more mediums. Some experiments in this direction were made, but apparently without much success. After the death of these two leaders in the research, it was natural to expect that they would themselves try something of the kind from "the other side," in order to give us evidence of their continued existence. And, as a matter of fact, this seems to have happened. The same message, almost word for word, was received from a Sidgwick-control through Mrs. Thompson, in London (sitter, Mr. Piddington, Hon. Sec. of the Society for Psychical Research), and Miss Rawson, in the South of France. But the telepathic difficulty again arises. The two messages were not exactly simultaneous. Is it not possible that Miss Rawson's subconsciousness made up the message (it was one giving some instructions to Mrs. Sidgwick about the preparation of her husband's "Life"), and then telepathed it to Mrs. Thompson? It is of course necessary to suppose, also, that the subconsciousnesses of the two mediums were in league to represent the message as coming from Dr. Sidgwick. But if the heart of man is deceitful above all things, and desperately wicked, there is no knowing to what depth of sin these newly-discovered "subliminals" may descend. We must hold them guilty until we have proved them innocent. In this case, once more, then, telepathy is not excluded.

At this point the ingenuity of the earthly investigators seemed to come to a stand. There seemed no way of getting round this omniscient and omnipotent telepathy. It seemed impossible to devise any experiment which should shut out with reasonable certitude the agency of minds still in the body. Just about this time, however, a curious thing happened.

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For some years after Mr. Myers's death in 1901, automatic writing had been regularly produced by several people of social and educational standing—not professional mediums, or even spiritualists—who were more or less in touch with the Society for Psychical Research, and whose script purported to emanate partly from the surviving mind of F. W. H. Myers. Chief among these automatists is Mrs. Verrall, Classical Lecturer at Newnham ; others are Mrs. Holland (an Anglo-Indian lady, who did not know Mr. Myers) and Mrs. Forbes, the widow of a well-known judge. These scripts contained much evidential matter, but it was usually open to the telepathic explanation, though some of it admittedly strained that explanation rather severely. Still, telepathy was *possibly* the true theory. But, in 1906, it was discovered by Miss Johnson (the Research Officer of the Society for Psychical Research) that there were curious concordances in these scripts, concordances which apparently had been going on for some time. It was found that one script, say Mrs. Verrall's, would contain a piece of writing which was apparently meaningless, and which was so treated by the automatist, while another script, say Mrs. Holland's, written about the same date, would contain a message equally meaningless in itself, but which, when compared with the similar one in Mr. Verrall's script, produced the most startlingly good sense. Here, then, apparently, was found evidence of initiative "on the other side," for none of the living investigators had thought of this plan of splitting a communication up and giving it piecemeal through different automatists. (See *Proceedings of the Society for Psychical Research*, Vols. XXI and XXII).

These remarkable phenomena are, however, still not quite conclusive. Perhaps the ingenious and sportive subliminals of the automatists concerned have arranged an elaborate system of impersonation, telepathing these message-fragments to each other, while the normal consciousnesses remain ignorant of all this below-decks cross-firing. The hypothesis cannot be entirely put aside; though it seems very improbable to those who have made a careful study of the whole mass of evidence. As Sir Oliver Lodge has said, it is too early to formulate dogmas, or even to express opinions (on the spiritualistic question) except in hesitating and tentative fashion. But the evidence now certainly seems sufficient to justify the holding of at least a working hypothesis that in these experiments the minds of "dead" persons are really playing a part.

This, however, is a very different thing from an acceptance of "spiritualism," with all its crudenesses and follies. The spiritualists—or most of them—accept any sort of trance-ravings or automatic scrawlings, as genuine "messages" from "the beyond." Psychical research, on the other hand, critically examines the content of the messages, applying the most drastic tests before even admitting other than known causes. If the communications contain nothing that is not known to the medium, psychical researchers dismiss them as of no interest; unless, indeed, there is a cross-correspondence involved—*i.e.*, the same message, or a related one, being given through another medium. If the medium's own knowledge is undeniably insufficient to account for the facts, then telepathy is invoked, and is stretched to a fearsome extent, amidst the violent diatribes of the spiritualistic press, which stigmatizes the Society for Psychical Research as a Society for Suppressing Knowledge. If telepathy begins to seem insufficient, some few bolder spirits of the Society (incarnate ones) venture on the tentative hypothesis of "telepathy from the dead;" but with careful hesitancy, leaving the door open behind them in order that they may flee back to the safety of former and more orthodox views, if further investigation should render the new tentative hypothesis untenable. This perhaps undignified but certainly wise position is that which is at present occupied by Mrs. Sidgwick (the ex-President of the Society), Sir Oliver Lodge, and other leading members of the Society for Psychical Research. The present writer, who is also a member of the Society in question, adopts a similar attitude. Personal investigation has convinced him of the truth of Hamlet's well-worn remark to Horatio, and he is even inclined to think that some of the evidence justifies us in thinking that (to be Shakespearian once more) not only can we call spirits from the vasty deep, but that sometimes they will *come* (though of their own free will) when we do call for them.

It is a difficult subject, not suitable for everyone. Emotional and unbalanced people should be warned off. Even religious people are doubtfully desirable: the investigation should be carried on, as far as possible, in the pure dry light of science, as it has been in the past, by men like Sidgwick, Gurney, Myers, and Hodgson. We want no recurrence of witchcraft and superstition, of which, perhaps—after the materialistic extremes of nineteenth century science—there is some danger, the pendulum of popular opinion being apt to swing from one side to the other. But, this said, we may follow up our researches with an easy mind. We are certainly on the track of something, whether (in Professor Barrett's phrase) it be a "new world" of being, or not. Careful and honest and patient investigation will no doubt yield its reward; but no sudden revelation is to be expected or desired. It may require the labours of many generations to unfold the full significance of the discoveries which are now being made. For it is not only in the (possibly) spiritistic direction that our pioneers are making progress; we are also finding out much concerning the unsuspected powers of the human mind (telepathy, clairvoyance, and so on), while it is still manifesting itself through a material brain in the ordinary earthly life.

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ON ADJUSTING AN EQUATORIAL BY MEANS OF CIRCUMPOLARS.

By E. ARDRON HUTTON, M.A.

THE average amateur astronomer usually suffers from the complaint of a holy discontent. He gets first of all a three-inch instrument on a tripod. He finds that he cannot conveniently use a power of more than one hundred and twenty, and so procures an equatorial stand and a couple of clasps, and then, by the aid of the usual text books, sets about its, or rather, their, adjustment. It must be confessed that the result is not always satisfactory, and in many cases a low power eyepiece is first used as a finder, a higher power being afterwards substituted. The object has then disappeared from the field before the new focus is found, and has to be "fished" for by the Right Ascension screw. Many of the objects in Webb cannot be seen at all with a low power, or at least cannot be distinguished when the field is crowded with stars, and thus much time is lost and many objects too. No amateur ought to be satisfied until he can infallibly pick up any object desired in a field of fifty to the inch of aperture.

The want of a sidereal watch can be easily supplied by obtaining a cheap Waterbury at the cost of half a guinea. Its adjustment to sidereal time, by aid of the "Sidereal time at Noon" given in Whitaker, is the work of a few days only, especially where a good clock is at hand. The first stroke of the hour from a public clock will usually be the best to adjust by, and if the time by the watch is put down on paper, the rate is easy to determine, but patience should be exercised, and the *exact* three minutes fifty-six seconds gain per day striven after. The subsequent rate may usually be relied upon to within very few seconds a day.

The adjustment of the clasps to the stand and to the telescope may then be seen to. The holes in the Declination plate should just fit the lugs of the clasp, and if there is any play wedges of thin zinc or tin (not wood), must be used. Two large washers for the screws to work against should also be provided, and everything should be screwed up well and firmly.

If the clasps are not quite right in size, two pieces of sheet lead of suitable thickness should be wrapped round the telescope, and then screw on the clasps. No wedges of irregular size and thickness must on any account be used. The telescope should, of course, be clasped tightly, and no play of any kind should be even suspected.

The adjustment of the instrument may then be taken in hand, and for this the method given in Chambers and Loomis leaves nothing to be desired, if faithfully and thoroughly carried out. Few, however, amongst amateurs do this, and hence a final testing by means of circumpolar stars is desirable and often essential.

For this purpose, either the upper or lower culmination of any circumpolar will suffice, but α and λ Ursae minoris are far the best, and the following method may be adopted.

A quarter of an hour or so before the actual culmination, the Declination circle should be brought to read the true Declination as given in the "Nautical Almanac," minus the correction for refraction. The R.A. circles should be set to the true R.A., and to time respectively, and the screws at the bottom of the Polar axis adjusted so as to bring the star exactly in the centre of the field of an eyepiece of not less than fifty to the inch of aperture, the telescope being East. Every care should be taken to perfect this adjustment and not to be content with mere approximation only. Exactness in this point is essential.

The telescope should then be swung over to the Western side and the circles re-fixed anew. If the star is too high or too low it is probably the Declination vernier that is wrong, and the star should be again centred by the Declination slow adjustment and the new reading taken. Half of this will be the error of the Declination vernier, and it must be altered accordingly. If the star is right in this respect, but appears to the East or West of the centre, a packing of thin metal must be put under one of the clasps until the error is halved. This is the commonest fault, and though it ought to have been detected before in the observation of six-hour stars, yet, too often, it is passed over as "near enough." A very small amount of packing will suffice, and nothing is more convenient than a sheet of thin lead from a tea chest, to be obtained at the grocer's for the asking. Again, however, we must insist on exactness, for nothing else will suffice. A second, or even a third, testing will be amply repaid. The time vernier may then be finally adjusted in the meridian by transit of an equatorial star, as given in the text books.

The consequence will be that powers of one hundred and fifty or two hundred may be used, with the assurance that the object will be in the very centre of the field of view with ordinary care in setting the circles. There will be no "fishing" or waiting, and above all there will be no mistaking one object for another, or concluding that it is beyond the power

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of the instrument. Six-hour stars will be equally easy, allowing, of course, for refraction, and the alteration of eyepieces will be speedily dispensed with. Above all, the amount of work done will be immensely increased, and the comfort of an exactly-adjusted instrument the better appreciated.

The larger the instrument the smaller the objects attacked, and the more necessary the exactness required, since oftentimes two or three doubles will be found in the field, and to know one from the other is by no means easy. A little care thus bestowed will be amply rewarded, and the observer will become the more satisfied with his hobby, and instead of *selecting* objects from Webb, will *work through* the book with ever-increasing satisfaction and delight.

CORRESPONDENCE.

THUNDERSTORMS IN GARESSIO.

To the Editors of "KNOWLEDGE."

SIRS,—The following notes and accompanying sketches

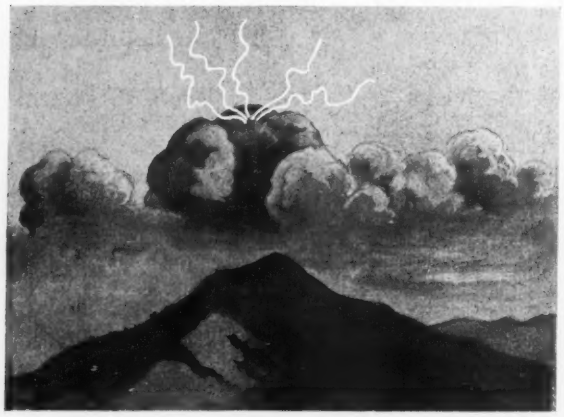

FIGURE 1.

Five long ribbons of Lightning.

were made at Garessio, a small town in the Ligurian Alps, about thirty kilometres inland from Alassio, and at an altitude of six hundred metres above the sea.

The summer in that part of Italy has been a remarkable one, not as has been the case in England and Northern

FIGURE 2.

Mamillated cloud after a thunderstorm, looking north. August 29th, 1911, 1.0 p.m. Garessio, Italy.

Europe, on account of the heat and drought, for our maximum temperature never exceeded 29° C. (84°·1 F.), and the first part of the summer was so exceptionally wet that crops and flower gardens suffered greatly. The characteristic of this summer which has made it a remarkable one was the extraordinary prevalence of thunderstorms, and the unusual intensity of the electricity developed. There were thunderstorms, either close at hand, or within visible and audible distance, on twelve days in June, twelve days in July, and sixteen in August.

In these storms, which usually culminated between one p.m. and four p.m., the lightning was magnificent, ribbons of fire running across the sky for miles, accompanied by a continuous roar of thunder. Usually the flashes leapt from one towering cumulus to another at an enormous height, and almost always without rain. Only on one occasion was there a little hail. I have endeavoured to sketch one remarkable flash, because neither I nor any of those who witnessed it can recall ever having seen a similar phenomenon. The sky had been dotted for several hours with curious irregular-shaped cumuli of extraordinary hardness and compactness, evidently highly charged with electricity, and ascending

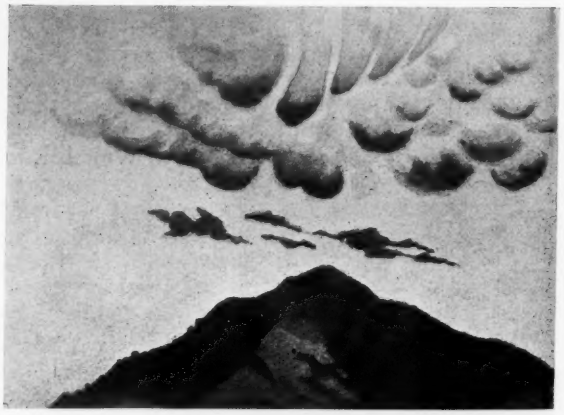

FIGURE 3.

Mamillated cloud after a thunderstorm, looking south. August 29th, 1911, 1.15 p.m. Garessio, Italy.

in tall columnar masses much like the steam from a locomotive's funnel. Suddenly one of these seemed to become over-charged, and a violent and very rapid discharge commenced, one flash of which I have endeavoured to depict. (Figure 1.) From a distinct centre of the cloud there burst simultaneously five long ribbons of lightning, which traversed a space of absolutely blue and cloudless sky, and ended abruptly in the blue, as shown in the sketch. There was no other cloud above or near the thundercloud, and the five streams appeared all of equal length. The sun had recently set behind the hills shown on the right, and the sky was still luminous and blue. I have never observed such a thing before, and should be interested to know whether it is a well-known phenomenon—that is to say, the lightning travelling out of a cloud into space and there terminating.

The two other sketches I send because I remember seeing a letter and illustration some time ago in "KNOWLEDGE," recording a mamillated cloud. These mamillated clouds are not

by any means uncommon amongst the Ligurian Alps, but I have never observed them except immediately after a thunder-storm, and they are apparently developed in that part of the thunder-cloud which represents the pointed end of the "Thor's Anvil," as it is sometimes called,—the long smudge which streams out behind at the opposite extremity to the advancing cauliflower-like front of the cumulus.

On the occasion on which the two sketches [Figures 2 and 3] were made, the whole sky was covered with these clouds. I took a photograph of part of it, but the result was too uniform in tone to come out well in reproduction. In my sketches I have slightly exaggerated the light and shade, but the forms were drawn with all possible care and accuracy. The rounded out lines of the pendant clouds appear to be due to the fact that the clouds are *descending*—that they are, in fact, cumuli upside down. After one of these storms we had the rather rare pleasure of seeing a perfect and very beautiful lunar rainbow (July 11th).

WM. PARKINSON (M.A., Oxon.)

OVIPOSITION OF TACHINIDAE.

To the Editors of "KNOWLEDGE."

SIRS,—I observed two of these flies the other day (July 25th, 1911) while attempting to lay eggs on the larvae of *Glottula dominica*, which were feeding on the leaves (and inside them, under the epidermis) of a species of Crinum.

One of them was feeling a larva near the head with its front pair of legs, as it now and again extended its ovipositor forwards under the thorax (I saw no eggs actually deposited).

The other saw the movements of a larva which was feeding under the transparent epidermis while about two inches off, and rapidly making its way there apparently succeeded in laying its eggs through the epidermis of the leaf on to the caterpillar, but of this I cannot be certain. The former larva was crawling on a neighbouring leaf and was not under cover, but it defended itself by swinging its tail round and discharging some liquid at the offending irritation.

I have noticed that a Tachinid is usually recognisable by the way in which the antennae stick out from the head during life, but the antennae of these two flies seemed to be in danger of getting broken off, and they reminded me irresistibly of a terrier's tail when he smells a rat!

L. G. GILPIN-BROWN.

STANDARD TIME IN PORTUGUESE TERRITORIES.

To the Editors of "KNOWLEDGE."

SIRS,—I beg to inform you that Standard Time will be in use from 1912, January 1st, throughout Portuguese territories, as follows:—

$8^h\ 0^m$ E.	Macao, Portuguese Timor.
$5^h\ 0^m$ E.	Portuguese India (provisionally $5^h\ 30^m$ E.).
$2^h\ 0^m$ E.	Portuguese East Africa.
$1^h\ 0^m$ E.	Portuguese West Africa.
$0^h\ 0^m$	(Greenwich, or West Europe).—Portugal, St. Thomé and Principe Islands, Whydah.
$1^h\ 0^m$ W.	Madeira, Portuguese Guinea.
$2^h\ 0^m$ W.	Açores, and Cape Verde Islands.

This Observatory remains entrusted with the determination and the telegraphic transmission of Standard Time to the whole country, to the Lisbon Time-ball, and to the Time Stations at the Meteorological Observatory, Ponta Delgada (St. Miguel, Açores).

I take this opportunity to state also that the most reliable geographical latitude of this Observatory is:

Lat. N. 38° 42′ 30″·5 (prime vertical, meridian, and zenith telescope series of observations from 1872 to the present, printed or unprinted),

and that the name "Lisbon, Tapada" is now the most suitable for it, like, for instance, "Florence, Arcetri," or "Naples, Capodimonte."

There has been built, and has now been working for two years a new astronomical observatory at Lourenço Marques, whose geographical coördinates are (transit pier):

Lat. S. 25° 58′ 4″·9 ± 0″·2 (Meridian observations by Capt. Gago Coutinho.)

Long. E. 32° 35′ 39″·4 ± 0″·05 (Moon culminations, simultaneously here, and geodetic connections with the Cape.)

Altitude (top of pier) 59 metres.

CANYOS RODRIGUES,
Vice-Admiral, P.N., Director.
Observatorio Astronomico de Lisboa.

DARK-GROUND ILLUMINATION AND ULTRA-MICROSCOPIC VISION.

To the Editors of "KNOWLEDGE."

SIRS,—In view of the great number and variety of dark-ground illuminators and appliances for ultra-microscopic observation which have come into existence, it is a matter for regret that makers have not always been felicitous in the choice of descriptive terms, and it is not improbable that in many cases this may have encouraged a pretty widely spread tendency on the part of users of the microscope to confound enhanced visibility with increased resolving power, with the result that a considerable amount of confusion has arisen respecting the fundamental aspect of the two modes of observation.

Neither the method of dark-ground illumination nor the so-called ultra-microscope can in any true sense of the term be regarded as a means of enhancing the resolving power of the microscope. In accordance with the undulatory theory of light this can only be accomplished by increasing the aperture of the optical system or by diminishing the wave length of the light. In their fundamental physical aspects the method of dark-ground illumination and the observation with the ultra-microscope are identical, and both serve to enhance the visibility of an object.

At the bottom of the secret which underlies these methods is the simple and familiar fact that brightly illuminated objects can be seen more distinctly on a dark back-ground than on one which is itself bright. Two things happen when a bright object is seen on a black ground; objects which were visible on a bright ground become much more distinct, and other particles which could not be seen before will come into view.

When this principle is applied to the microscope it is found that in the field furnished by the method of dark-ground illumination details can be observed, especially in preparations containing micro-organisms, which cannot be recognised under ordinary circumstances, though dimensionally they are well within the resolving power of the microscope. In addition, particles become so far visible that their presence can be perceived, and this despite the fact that their dimensions may be considerably smaller than the wave length by which they are seen, and accordingly beyond the resolving power of the microscope.

So long as the objects as seen in a dark field exhibit structural details and well defined contours we are dealing with simple dark-ground illumination. When, on the other hand, the field is seen to contain particles in which there is not a visible trace of detail and which accordingly present the appearance of bright point-like discs, generally surrounded by bright and dark rings, the case is one of ultra-microscopic observation, and the particles whose presence is thus perceived are ultra-microscopic.

It will thus be seen that the difference lies solely in the manner of observation and not in the nature of the apparatus. On the other hand, ultra-microscopic observation implies dark-ground illumination, whilst it is not every form of dark-ground illumination that constitutes an ultra-microscope. For this reason it is most desirable that the various appliances should bear appellations from which it is at once apparent that they are primarily intended for dark-ground illumination, pure and simple, or for ultra-microscopy, as the case may be, *i.e.*, dark-ground illuminators should be named so as to distinguish them from ultra-microscopes.

It should, however, not be overlooked that in practice it

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frequently happens that a dark-ground illuminator, *i.e.*, a condenser primarily devised for ordinary microscopic observation in a dark field, is available for ultra-microscopic observation; indeed, in many cases both kinds of observation are made concurrently. The examination of a preparation of saliva furnishes an instance of this. With our concentric condenser (after Dr. Jentzsch of our Scientific Department) one can see in this medium a few organisms moving across the field in snake-like fashion, and others of a rod-like shape, whilst in addition to these there are to be seen bright discs surrounded by one or several bright rings and executing quivering movements. The latter come into view by an ultra-microscopic process, whilst the others are seen under simple dark-ground illumination, though sometimes their transverse dimensions are of the ultra-microscopic order.

It is to be hoped that in future, makers as well as users of these optical instruments will endeavour to prevent a continuance of the misunderstanding at present existing, by employing the correct term, especially when referring to dark-ground illumination of micro-organisms. E. LEITZ.

THE NEW ASTRONOMY.

To the Editors of "KNOWLEDGE."

SIRS,—I was delighted to see your able statement of the facts confirming Professor Bickerton's theory in your August issue, and still further pleased to read his remarkable articles, on the story of Nova Persei, and on double and wonder stars.

I have always loved astronomy, and for thirty years I have been a Fellow of the Royal Astronomical Society, and during all that time nothing has interested me so much as this beautiful theory of the third body.

At Professor Bickerton's lecture at the Royal Colonial Institute, I heard Mr. Knobel, who has been twice President of the Royal Astronomical Society, express his opinion so strongly, that I was delighted. He said: "It has been an extreme pleasure to me to listen to Professor Bickerton's eloquent address. I have given some attention to astronomy myself, and I can say, that the basis of Professor Bickerton's theory is such, that it must command, not only the attention and consideration, but I think, the assent of the majority of astronomers."

Since this lecture as I have gradually realized how far-reaching is the scope of the principle of the third body, with its power to capture, its explosive energy, and its capacity to sort its atoms, I have come to believe that this generalization marks an epoch in astronomy. I heard Professor Bickerton debate the subject, at the British Astronomical Association, and was struck with the ease with which he confuted the objections of able astronomers. Hence I felt assured that the theory had come to stay, and subsequently his letters in *The Times* confirmed this impression. I have read and re-read his book, "The Birth of Worlds and Systems" published in "Harper's Library of Living Thought." Its study convinces me that the theory of Professor Bickerton's is the only one that corresponds with the facts of observational astronomy. With regard to novae, the question so ably discussed in the September number of "KNOWLEDGE," I have personally compared the light-curve, and series of spectrograms of Nova Persei, with the complex deductions made from the dynamical study of the third body, and they fit perfectly. I believe that the Southern Astronomers are right when they say that, "had the idea been used from its inception, merely as a working hypothesis to guide celestial observations, astronomy would have been years ago where it is now." The Government of New Zealand has shown its deep interest in basic science, and deserves the gratitude of the learned societies, in sending Professor Bickerton to explain his New Astronomy to the scientific world. J. MCCARTHY, F.R.A.S.

TO FIND APPROXIMATELY SIDEREAL TIME.

To the Editors of "KNOWLEDGE."

SIRS,—The state of the sky at a particular hour may be approximately ascertained by the use of the simple equation

R.A.=h+2m+5, where h is the hour counting from midnight, and m the number of the month.

This will give the R.A. of the zenith, or Sidereal Time on the 7th of the month, within a few minutes. By the daily allowance of four minutes the R.A. on any other day of the month may be determined. Thus, on the 22nd of the month the R.A. will =h+2m+6.

N.B.—For greater accuracy in January and February the dates should be the 6th and 21st, and in March, May and July the 8th and 23rd.

Example: At noon on November 29th, seven days after the 22nd; R.A.=12+22+6h. 28m.=XVI.28′. The correct time, as shown by *Whitaker's Almanack* is XVI.29′ 1″.

Again, if the R.A. of a particular star or constellation is known, its position in the sky at any date and hour may be calculated.

Example: The R.A. of Sirius is VI.41′. To find the time of its southing on 15th March, seven days after the 8th.

R.A.=VI.41=h+6+5h. 28m.

∴ h=−5h. 47m., which signifies 5 hours 47 minutes before 24 o'clock or midnight; which will be XIX. 13 o'clock, or 7.13 p.m.

Again, to find the date on which a given meridian will be south at a particular hour.

Example: When will Altair, R.A. XIX.46, be south at 9.30 p.m.?

R.A.=XIX.46=21h. 30m.+2m+6h. 16m.

(The last figure must be chosen, so that the value of 2m will be even.)

∴ 2m=XIX.46−XXVII.46=−8,=+16, ∴ m=8.

The date will be August 26th, four days after the 22nd. By Whitaker, R.A. at noon on August 26th is X.14; at 9.30 p.m. it is XIX.44.

In the absence of a Star Atlas or Map, the following lines may be useful:—

MEMORIA TECHNICA*

showing the position of the principal stars in the sky.

Sedes, Andromeda, et PISCES, et Cetus, Achernar.
Perseus, Pleïadesque, ARIES, Mira, Eridanusque.
Auriga, Orion, TAURUSque, Lepusque, Columba.
Tum GEMINI, Procyon, et Sirius, atque Canopus.
CANCER, et Hydra, Argo, cui puppim vela sequuntur.
Indicat Ursa Polum coeli, tergumque LEONIS.
Cauda, Canes, VIRGO, Corvus, Crux, et Centaurus.
Ursa, Draco, Arcturusque, Corona, et LIBRA, Lupusque.
Etanin, Heracles, Ophiuchus, SCORPIO, et Ara.
Vega, Caput Cygni, Volucerque Tonantis, et ARCUS.
Cepheus, et Cygnus, Pavo, CAPRICORNUS, et Indus.
Pegasus, Australis quoque Piscis, AQUARIUS, et Grus.

These lines, taken in order, give the constellations found in the segments of the sky contained between the R.A. meridians XXIV and II, II and IV, IV and VI, and so on.

FRED B. TAYLOR.

THE PURKINJE PHENOMENON.

To the Editors of "KNOWLEDGE."

SIRS,—It is a matter of common observation that coloured objects change their aspect in a remarkable manner just after sunset. If, for instance, when twilight has set in, we look about us in a garden containing flowers of various hues, or in a library full of many coloured books, we soon become aware of a striking change which has taken place in the relative brightness of the tints surrounding us. We notice that the blues are much lighter, and the reds much darker than when they are seen in ordinary daylight. So marked is this phenomenon at times, that certain blue tints appear almost white, while red tints, on the other hand, become so dark that they might be mistaken for black, if, indeed, they do not entirely pass unnoticed. The cause of this well-known effect, which bears the name of the Bohemian physiologist Purkinje (1787–1869), who first described it, generally receives its explanation in the peculiar differential colour sensitiveness of the eye, which loses sight of a red sooner than a green ray,

*Note.—Line 1—Sedes is Cassiopeia's Chair; line 5—Argo rises stern first; line 7—Cauda is the Bear's Tail; line 10—Volucer Tonantis is Aquila.

when adapted to twilight vision. The eye, in fact, according to this view, *must* be adapted to twilight, or must have the so-called "Dark-adaptation," before the phenomenon can be produced. The retinal apparatus of the eye undergoes a certain change when dark-adaptation occurs, the rods of the retina, which are distinguished from the cones by the possession of a substance peculiarly sensitive to the action of light known as "visual purple," being more particularly involved in the process.

So much, then, for the *physiological* explanation of those curious changes in the relative brightness of colours at dusk, known as the "Purkinje Phenomenon," and this is, in essence, the explanation given by Dr. Charles S. Myers in his recent science manual "An Introduction to Experimental Psychology"*; but it appears to me that there are other factors of a purely *physical* character—factors which I have so far never seen adduced—which also conspire to bring about the remarkable effects observed.

Every photographer must be familiar with the extraordinary change of aspect which coloured objects suffer when seen under the red rays of the dark room. Reds appear very bright, and blues correspondingly dark, for he is regarding them by what is practically monochromatic light of a red hue, and only those objects whose surfaces are capable of reflecting the red light waves will show brightly; all others must appear dark in comparison. Now, when the Sun has set, we have the reverse phenomenon, for our source of illumination is the blue sky only. The Sun, which sends us rays of all wave-lengths, being below the horizon, surrounding objects can only be rendered visible by the sunlight reflected from the minute particles of the atmosphere, and these, as we know, send us predominantly light of short wave-length, so that we here again have a quasi-monochromatic effect. This bluish light, therefore, will be strongly reflected by all objects of a blue tint, rendering them brightly conspicuous, while, conversely, all red objects will appear correspondingly dark—we shall have, in point of fact, a display of the Purkinje Phenomenon.

While in no way venturing to impugn the validity of the physiological interpretation of the phenomenon, as first described, it seems to me that we possess in the purely physical aspect of the question an equally powerful, if generally neglected, factor contributing towards the identical result.

W. ALFRED PARR.

NAKED-EYE COMETS.

To the Editors of "KNOWLEDGE."

SIRS,—The fact that four comets have been visible to the naked eye within two months must furnish a fact of exceptional rarity. I saw Kiess's comet on August 3rd without telescopic aid, Brooks's on August 15th, and Quenissett's on September 28th. And during the past few mornings Beljawsky's comet has been very generally seen as a conspicuous object in Leo.

Bristol, *October 8th.* W. F. DENNING.

ASTRONOMICAL QUERIES.

To the Editors of "KNOWLEDGE."

SIRS,—May I be allowed to thank Dr. Crommelin and the Rev. M. Davidson for their lucid replies to my questions in your issue of August, and to add some further remarks?

On the first two questions I have nothing further to say, except to express surprise that the *Nautical Almanac* should publish the time of greatest brilliancy of Venus to the nearest hour when such accuracy is of no significance. In this connection I should like to refer to the ease with which the planet was seen at Hampstead at inferior conjunction on September 15th, when within nine degrees of the Sun himself.

With reference to my third question, dealing with the Moon's secular acceleration, I had no intention of submitting an astronomical catch but was in a real difficulty, though I found the fallacy in my own argument shortly afterwards. My solution, which agrees in its results with that of Mr. Davidson, is as follows:

Taking D, the disturbing acceleration (using the same notation as Mr. Davidson), as proportional to the reciprocal of the third power of the earth's radius vector,

Then the average value of D throughout a complete revolution of the earth is

$$D' = K \frac{2}{T} \int_0^{\frac{T}{2}} \frac{dt}{R^3}, \text{ where K is a constant.}$$

From Kepler's Law, $R^2 \frac{d\theta}{dt} = C$, a constant.

$$\text{Hence, } D' = \frac{K}{C} \frac{2}{T} \int_0^{\pi} \frac{d\theta}{R}.$$

From the equation to an ellipse, $R = \frac{b^2}{a(1 + e\cos\theta)}$,

$$\text{Hence, } D' = \frac{K}{C} \frac{a}{b^2} \frac{2}{T} \int_0^{\pi} (1 + e\cos\theta)\, d\theta.$$

$$= \frac{K}{C} \frac{a}{b^2} \frac{2\pi}{T}.$$

$$\text{Also, } T = 2\int_0^{\frac{T}{2}} dt = \frac{2}{C} \int_0^{\pi} R^2\, d\theta;$$

But $d\theta = \frac{b}{R}\, d\phi$, where ϕ is the complement of the eccentric angle,

And $R = a(1 + e\sin\phi)$.

$$\text{Hence, } T = \frac{2ab}{C} \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} (1 + e\sin\phi)\, d\phi$$

$$= \frac{2ab\pi}{C},$$

$$\text{Hence, } D' = K \frac{1}{b^3} = K \frac{1}{a^3(1 - e^2)^{\frac{3}{2}}}.$$

From this it *appears* that, as e decreases and D' consequently decreases, the Moon will be accelerated. But yet I am not satisfied. The problem is to show that the *average* angular velocity of the Moon in her orbit increases as the eccentricity of the Earth's orbit decreases. The above shows that the *average* perturbing acceleration decreases with the eccentricity, and we know that the angular velocity increases with decrease of perturbing acceleration; but I submit that these are not sufficient to prove the proposition. It seems possible that there may lurk here a fallacy similar to that with which I began this correspondence.

Perhaps my meaning will be clearer if I put the matter into symbolic form. The angular velocity, ω, being a function of D, we have $\omega = \psi(D)$ say.

We know that $\frac{d(\psi(D))}{dD}$ is negative, (1)

We have found that $\frac{d\left(\int_0^T D\, dt\right)}{de}$ is positive (2)

But does it necessarily follow that

$$\frac{d\left(\int_0^T \psi(D)\, dt\right)}{de} \text{ is negative?} \quad (3)$$

We still require to know the relationship $\omega = \psi(D)$.

I do not, of course, doubt the well-recognised truth of (3), but I venture to think that it does not follow from (1) and (2).

C. O. BARTRUM.

* Cambridge University Press, 1911.

PLANT HAIRS.

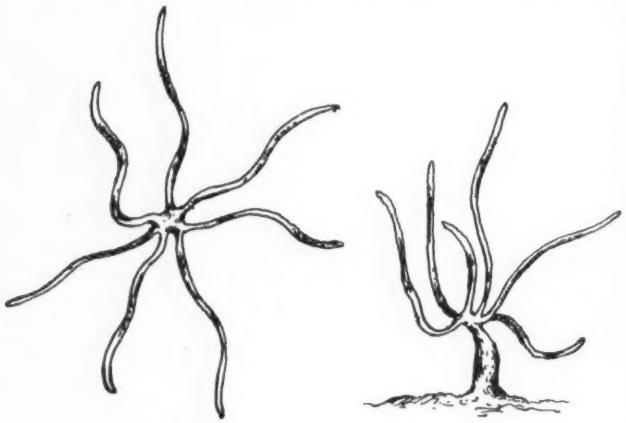
By K. E. STYAN.

(Continued from Page 248).

IV.—(*a*) STELLATE AND (*b*) PELTATE PLANT HAIRS.

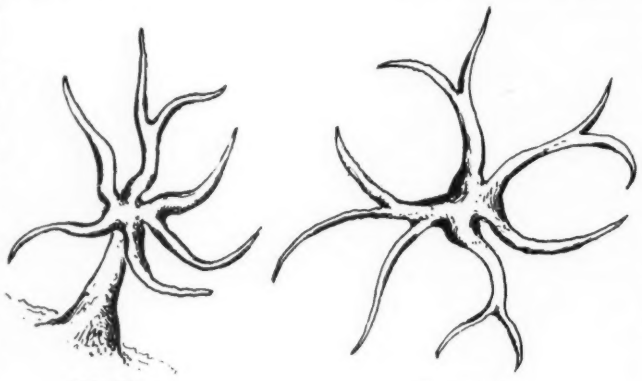
As the word implies, stellate hairs are rayed and starlike, though the rays spread out in all manner of strange ways (some of them being simple, others branched into two or more arms) and are very irregularly placed at the tip of the pedicel from which they spring. So strange are they that, when first seen under the microscope, one finds it hard to realise that such structures are *hairs*. Yet they are so, and to their presence on a plant is due much of the external beauty that we see so clearly with the naked eye, for they often grow in such dense masses and are so soft, woolly, silky or scaly that a thick network, "felt" or "down" is formed, and this woven, silvery-white dress, on the surface of many leaves and other plant organs, is something really charming to behold. The wanderer on a lone tract of open salt marsh stands entranced—if he be either botanist or artist—at the glory of a mass of Sea Wormwood, decked in silvery sheen, glistening in the sunshine, yet equally exquisite in shadow. The beauty of this plant lies in its "felt-like" covering, every particle of which is made up of stellate hairs! Our garden Lavender (see Figure 3) is covered with a greyish "bloom" by which means the foliage forms such a perfect setting for the lilac of the blossoms. Every atom of this "bloom" is nothing less than myriads of charming stellate hairs, branched and simple, springing from the leaf epidermis on short, rather thick pedicels. Some of the rays are long,, others short, and all are more or less sharp-pointed. In the Ivy (see Figure 4) each hair has from three to nine rays, branched or not, and distinctly broad and flat, each ray springing from the top of a long stem. Figure 2 showing illustrations from the leaf surface of garden white arabis, brings before us some of the quaintest stellate forms of which it is possible to conceive. A front view of such a hair has rather the appearance of a set of stag's antlers, whilst a side view looks rather like a tree with trunk and branches. If the leaf of Arabis be examined, its surface will be found to be very rough; this roughness is caused by the hairs upon it, and it is easy to realise why the leaf should be so scabrous when we find what remarkable hairs grow all over it. Apparently in different plant species the number of rays on each hair differs to some extent, though taken as a whole the number ranges between three and fifteen.

One large natural order of plants, the Compositae,



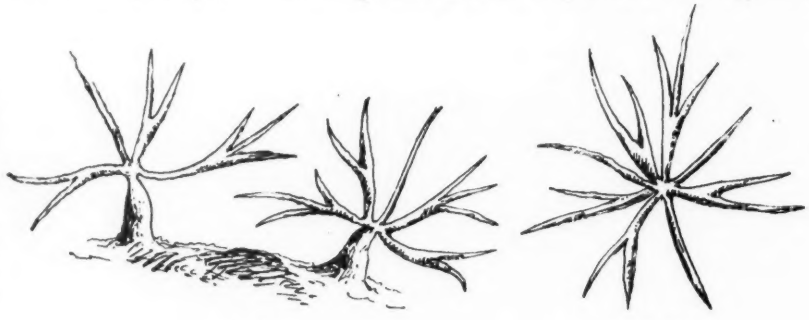
Front View. Side View.

FIGURE 1.
Stellate Hairs from the Stem and involucral bracts of Mouse-ear Hawkweed.



Side View. Front View.

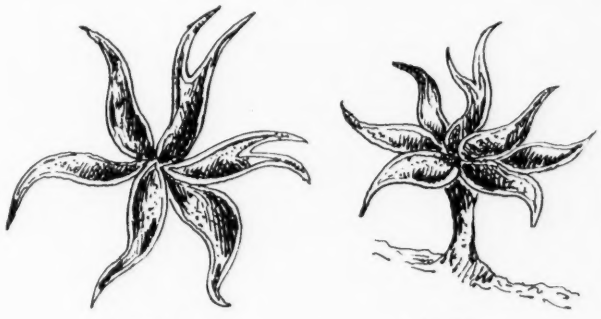
FIGURE 2.
Stellate Hairs from the leaf of White Arabis.



Side View. Front View.

FIGURE 3.
Stellate Hairs from the "felt" on the leaf surfaces of Lavender.

possesses a number of species specially noted for the "felt" on the under-surfaces of their leaves, stems, and so on. If only one be selected for examination, say the pretty little Mouse-ear Hawkweed, this one plant will afford much that will interest us, for the starfish-like hairs which form the "felt" are the most fascinating objects. Figure 1 represents some of them from the involucral bracts of the flower-head, but the leaves and stems of this plant are also covered with the same pretty silvery structures,



Front View. Side View.

FIGURE 4.

Stellate Hairs from the flower pedicels of Ivy.

very delicate and very chaste; and other lovely examples may be found on the leaves and stem of Hollyhock; amongst the Mallows; in the curious growths called "Oak spangles" or "galls," and in a great many other common garden and wild plants.

It is difficult to say *why* hairs should become "stellate," yet one can see that their form is well adapted for the forming of "down" or felt-like growths, which no doubt play an important part in the protection of plant-surfaces.

Strange as are the stellate, the peltate or shield-like are, perhaps, the most curious of all the many different hairs with which we meet. Their appearance on a plant often causes the surface on which they spring to look, and feel, very scurfy and roughly scaly, for which reason the term "lepidote" has been given to such hairs, the word "lepis" being another name for "scurf."

Such a hair as this grows from the epidermis of leaf, stem, and so on, in such a way that it is attached to it by its centre, and projects on either side in a horizontal way, thus forming a kind of shield or very flattened plate, which is membranous in texture, built up of many cells, and either more or less smooth and even round its margin, or cut up into numbers of sharp, delicate teeth of many varying lengths. It is owing to the presence of these "plates" that many plants present a scaly, scurfy surface. One need but look at Figure 6, a hair taken from the leaf surface of *Eleagnus*, to understand the reason for the leaf's lepidote appearance, nor can one well wish to see anything more rich in form than this flatly-expanded, toothed, radiating peltate hair, when seen under the microscope.

Other plants show different peltate forms, such as the Sea Buckthorn, the paleae of many young ferns, the Wallflower and many other cruciferous plants, Cornel, and so on. Figure 5 illustrates one taken from the leaf of Wild Cornel, and this is exactly the same in form as a similar hair from the Wallflower leaf. It is curious to note how masses of these low-growing, expanded flat hairs deck the leaf-surface, all more or less of the same size and height, the splayed tips almost poking into each other.

FIGURE 5.

Peltate Hair from the leaf of Cornel.

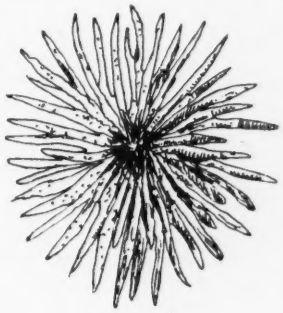


FIGURE 6.

Peltate Hair from the under surface of the leaf of *Eleagnus*.

V.—(*a*) JOINTED (*b*) CLUBBED PLANT HAIRS.

Jointed hairs, compared with other forms on the whole, are by no means so common, yet they are met with in considerable numbers, and may be very well seen on the leaves of Hedge Woundwort and many of its allies in the large Natural Order, Labiatae; in Common Fleabane, Bugle, Mossy Saxifrage, Foxglove, Germander Speedwell, on the plants from whence the accompanying illustrations have been taken, and on the loose, hairy tissue on the surface of the stigma in many of the Orchidaceae.

If a hair of this kind be examined it will be found to show, at certain marked distances up its length, peculiar swollen joints that look very much like a series of knuckles, which seem to fit into sockets, the latter being much more clearly noticed in some instances than in others. The Purple Dead-nettle (see Figure 8) shows interesting examples of good jointed hair structures, which are extremely sharp-pointed. Those on the stem of one of the common garden species of *Harpalium* (see Figure 9) are really quaint-looking little things with their thickened joints, curved, sharp tips, and remarkably rough surfaces: indeed, imagination can almost liken them to the claws of a crab! Figure 10, representing a hair from the stem of the Mouse-ear Chickweed, is one the prettiest of all, perhaps, for there is a slenderness about it that is graceful, and the way in which joint fits joint is beautiful. In the Pineapple Sage (see Figure 7) are some glandular hairs, on the veins of the leaves, and the pedicels of these are distinctly pointed. When touched firmly, this plant emits a delicious odour of pineapple (which probably

gives it its name), owing to the secretion formed within the hairs. Those people who have ever had the handling of Jerusalem Artichoke plants will know that their leaves are extremely rough, but few of them know that this fact is owing to the presence of countless myriads of sharp-tipped, jointed hairs that are, if anything, even more rough than those of the *Harpalium*, a plant of the same natural order. It needs but a microscope to show the bristling, scabrous upper coats of these simple, jointed structures, and we can then easily understand why the leaves feel so rough and unpleasant to the touch.

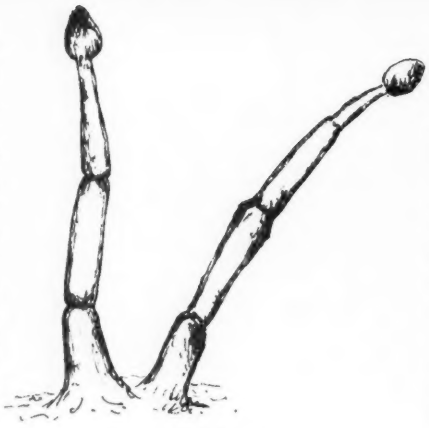


FIGURE 7.
Jointed Hair from the leaf veins of Pineapple Sage.

Clubbed hairs are very often known as Clavate, or club-shaped, and are so marked in their features that it is difficult to overlook them even when they grow—as is often the case—in company with masses of ordinary long and simple, or other forms of hairy appendages. Some very nice examples may be seen in the White Campion and Pansy; in Avens and the interior of Willow-galls, and so on, but one of the best plants is the Scented Geranium. It is owing to the presence of these hairs on this plant that we get the delicious odour when the leaves and stems are pressed, for the hairs are glandular, but of so distinct a form that they are classed by themselves as the "clubbed." Figure 11 clearly shows some from the stem of the Geranium, and one can note the simple (*i.e.*, unbranched), thick-coated hairs, each of which is just like a club standing up on a curious swollen base. They are very pretty objects both individually and in the mass, and perhaps the fact that they are comparatively uncommon makes them all the more interesting when we come across them, as is often the case, unconsciously; for very often one kind of hair is met with exclusively on a plant, but at other times one may suddenly come across another kind interspersed just here and there, and no more. In this uncertainty lies the charm of real observation work, be it with the naked eye or microscope.

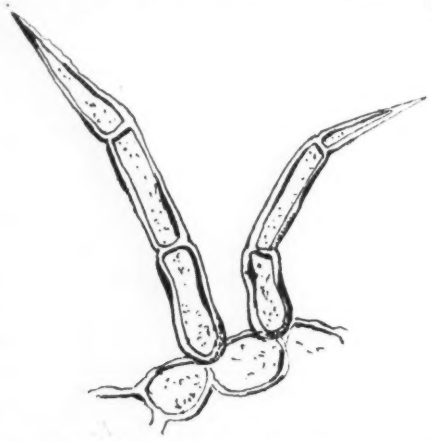


FIGURE 8. Jointed Hairs from the calyx of Purple Dead Nettle.

FIGURE 9. Jointed Hairs from the stem of Harpalium.

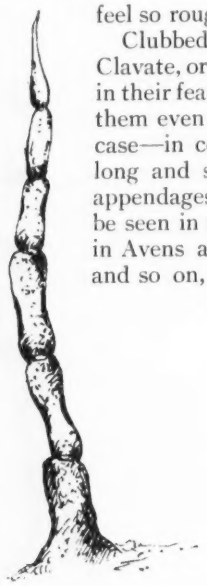


FIGURE 10.
Jointed Hair from the stem of Mouse-ear Chickweed.

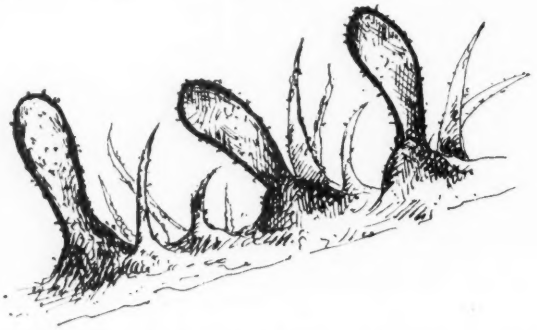


FIGURE 11. Clubbed Hairs from the stem of Scented Geranium.

FIGURE 12.
Jointed Hair from the edge of Jerusalem Artichoke.

THE FACE OF THE SKY FOR NOVEMBER.

By W. SHACKLETON, F.R.A.S., A.R.C.S.

THE SUN.—On the 1st the Sun rises at 6.54 and sets at 4.34; on the 30th he rises at 7.43 and sets at 3.54. Sunspots and faculae may occasionally be seen on the disc, but of late spots have been small, although faculae have been fairly conspicuous. The equation of time is a maximum on the 4th, the Sun being $16^m\ 21^s$ in advance of the clock, thus making the afternoons short and the mornings long. The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre of Disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Nov. 2	24° 33′E	4° 13′	227° 37′
,, 7 ...	23° 35′E	3° 41′	161° 41′
,, 12 ...	22° 26′E	3° 7′	95° 46′
,, 17 ...	21° 5′E	2° 32′	29° 52′
,, 22 ...	19° 34′E	1° 56′	323° 58′
,, 27 ...	17° 51′E	1° 19′	258° 3′
Dec. 2 ...	15° 59′E	0° 40′	192° 10′
,, 7 ...	13° 57′E	0° 2′	126° 16′

THE MOON:—

Date.	Phases.	H. M.
Nov. 6 ...	○ Full Moon	3 48 p.m.
,, 13 ...	☾ Last Quarter	7 20 a.m.
,, 20 ...	● New Moon	8 49 p.m.
,, 29 ...	☽ First Quarter	1 42 a.m.
Dec. 6 ...	○ Full Moon	2 52 a.m.
Nov. 8 ...	Perigee	6 12 p.m.
,, 24 ...	Apogee	4 24 p.m
Dec. 7 ...	Perigee	1 0 a.m

There is an eclipse of the Moon on the 6th, but as the moon only passes through the penumbra of the earth's shadow very little darkening will be observable; moreover, one will only be able to observe the end of the eclipse and that under bad conditions, as the moon will be low down. The particulars of the eclipse are given below:—

	Nov. 6
First contact with the Penumbra ...	1.39 p.m.
Middle of Eclipse	3.37 p.m.
Last contact with the Penumbra ...	5.34 p.m.
Moon rises (at Greenwich)	4.17 p.m.

OCCULTATIONS.—The following are the principal occultations visible from Greenwich:—

Date.	Star's Name	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point. E.	Mean Time.	Angle from N. point. E.
			p.m.		p.m.	
Nov. 7	32 Tauri ...	5·8	7.23	14°	7.57	299°
,, 10	47 Geminorum...	5·6	—	—	7.36	306°
,, 11	λ Cancri ...	5·9	9.7	153°	9.35	219°
,, 29	ψ^2 Aquarii ...	4·6	9.15	80°	10.16	212°
			a.m.		a.m.	
Dec. 7	136 Tauri ...	4·6	1.46	19°	2.11	337°

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
Oct. 29 ..	14 25	S 14° 20′
Nov. 8 ...	15 27	S 19° 53′
,, 18 ...	16 30	S 23° 49′
,, 28 ...	17 33	S 25° 44′
Dec. 8 ...	18 27	S 25° 20′

Mercury is in the neighbourhood of the Sun at the beginning of the month, but towards the end of the month the planet becomes an evening star in Scorpio, setting at 4.42 p.m. on the 27th November.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
Oct. 29 ...	11 28	N 2° 3′
Nov. 8 ...	11 59	N 0° 20′
,, 18 ...	12 53	S 2° 15′
,, 28 ...	13 11	S 5° 25′
Dec. 8 ...	13 51	S 8° 52′

Venus is a morning star in Virgo, and is at greatest westerly elongation of 46° 45′ from the Sun on the 26th, when she rises E. by S. at 3.5 a.m.

The planet appears as a very conspicuous object in the morning sky looking east. The apparent diameter of the planet is about 30″, whilst 0·5 of the disc appears illuminated; thus the telescopic appearance is that of "half moon."

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
Oct. 29 ...	4 34	N 21° 49′
Nov. 8 ...	4 23	N 21° 58′
,, 18 ...	4 9	N 21° 53′
,, 28 ...	3 53	N 21° 37′
Dec. 8 ...	3 39	N 21° 16′

Mars is a very conspicuous object in the S.E. portion of the evening sky, where he appears as a very bright red star a few degrees to the South-east of the Pleiades. The planet is visible throughout the night, as he rises about sunset and sets about sunrise. The planet is in opposition to the Sun on the 25th, when he appears due South at midnight. This opposition is a very favourable one as regards the altitude of the planet, though not so favourable as regards nearness to the earth, compared with oppositions in 1907 and 1909. The planet's altitude on this occasion reaches 60° when on the meridian, whilst the apparent diameter of the disc is 18″, corresponding to a distance of about 48½ million miles. Below is given a table showing the altitude and comparative distance of several oppositions:—

Opposition.	Declination.	Altitude.	Relative Distance from Earth.
1905	S 16° 57′	21½°	0·537
1907	S 27° 1′	11½°	0·408
1909	S 4° 11′	34°	0·390
1911	N 21° 42′	61°	0·517

XUM

The latitude of the planet's centre is —10°, hence the southern hemisphere is inclined towards the earth, and is in the best position for observation; but little of the snow cap is visible as it has dwindled to small dimensions in the advancing summer of the Martian Southern Hemisphere. The dark markings, according to Lowell, should, during the summer of the hemisphere under observation, be increased in intensity. In telescopes of 3 or 4 inches aperture the dusky markings on the disc are observable when the seeing is good. The time of rotation is $24^h\ 37^m\ 23^s$, approximating to that of the earth, so that the same regions may be scrutinized on successive evenings. The well-known marking of the Syrtis Major is visible on the 12th about 10 p.m., and the Solis Lacus on the 28th at 9 p.m. The two small satellites, Phobos and Deimos, are only visible in the largest telescopes.

The moon appears near the planet on the morning of the 8th.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
Oct. 29 ...	15 14	S 17° 11′
Nov. 8 ...	15 23	S 17° 45′
,, 18 ...	15 32	S 18° 19′
,, 28 ...	15 41	S 18° 50′
Dec. 8 ...	15 50	S 19° 20′

Jupiter is in conjunction with the Sun on the 18th, after which he becomes a morning star; during November, however, he is practically unobservable, being lost in the Sun's rays.

SATURN:—

Date.	Right Ascension.	Declination.
	h. m.	
Nov. 1 ...	3 3	N 14° 35′
,, 16 ...	2 58	14° 15′
Dec. 1 ...	2 53	N 13° 58′

Saturn is a very conspicuous object in the evening sky, rising E.N.E. immediately after sunset. The planet is about 15° to the West of Mars, and the two bright planets form a striking pair.

Saturn is in opposition to the Sun on the 10th, and thus is due South at midnight about this date.

The telescopic view is splendid, as the rings and belts are readily seen even when seeing is comparatively poor. In addition to the ring, the belts on the disc and also some of the numerous satellites may be observed. A telescope of three inches aperture is sufficient to show the four larger satellites, namely, Titan, Japetus, Rhea, and Tethys. Titan is generally to be looked for at a considerable distance from Saturn, not only to the sides, but also apparently above and below the planet.

The division in the ring may be seen in a good telescope of two inches aperture; whilst the dark ring requires an aperture of four inches, with good atmospheric conditions.

The apparent diameters of the outer major and minor axes of the ring system are respectively 47″ and 17″, and we are looking on the Southern surface at an angle of 21°, so that the ring appears open. The diameter of the ball is 18″. The ring is visible with a power of about 50, and the belts with a power of 80. The moon appears near the planet on the evening of the 6th.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Nov. 1 ..	19 51 4	S 21° 33′ 4″
Dec. 1 ...	19 55 23	S 21° 20′ 55″

Uranus is unfavourably placed for observation on account of his low altitude. He is situated low down in the S.W. portion of the sky at Sunset, and sets at 8.30 p.m. on the 15th. The planet appears in Sagittarius, in a part of the sky devoid of good reference stars, though the star σ Sagittarii is about 5° to the N.E.

NEPTUNE:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Nov. 1 ...	7 42 16	N 20° 47′ 6″
Dec. 1 ...	7 40 55	N 20° 50′ 8″

Neptune rises about 8.30 p.m. near the middle of the month and crosses the meridian about 4 a.m. Thus he will be in a better position for observation a few months later. The planet is located in Gemini, nearly midway between 68 Geminorum and ψ^2 Cancri.

METEORS.—The principal meteor showers during the month are the Leonids and Andromedids:—

Date.	Radiant.		Characteristics.
	R.A.	Dec.	
	h. m.		
Nov. 14-16 ..	10 0	+22°	Swift, streaks. (*Great Leonid* shower).
,, 17-23...	1 40	+43°	Very slow, trains. (*Great Andromedid* shower).

Algol will be at minimum on Nov. 1st at 11 p.m., 4th at 8 p.m., 7th at 5 p.m., 24th at 9 p.m. and 27th at 6 p.m. The period is $2^d\ 20^h\ 49^m$ from which other minima may be deduced.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—η Cassiopeiae $0^h\ 43^m$, N. 57° 17′, mags. $3\frac{1}{2}$, $7\frac{1}{2}$; separation 6″·1. Binary star.

λ Arietis $1^h\ 52^m$, N. 23° 6′, mags. 4, 8; separation 37″. Components white and blue; easy with power 20.

η Persei $2^h\ 44^m$, N. 55° 28′, mags. 4, 8; separation 28″. The brighter component is orange, the other blue. There are also several other fainter stars very near.

QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed here.

QUESTIONS.

54. I have a copy of the *Nautical Almanac* for 1911, and monthly compare the results given in "The Face of the Sky" supplied by Mr. Shackleton, F.R.A.S., and have often wished that I could so correct the tables as to make them applicable to any place other than Greenwich.

Will you kindly enlighten me through your columns on the following:—

(*a*) What is the formulae to obtain the inclination of the Sun's axis from the W. point?

(*b*) What is the formulae to obtain the heliographic latitude of the centre of the Sun's disc?

(*c*) What is the formulae to obtain the heliographic longitude of the centre of the Sun's disc?

Also:—Is there any way that I could apply the difference in time between Greenwich and Sydney to the tables of the *Nautical Almanac*, pages 513 and so on, showing position of Jupiter's satellites, so that they would be shown as they would appear at Sydney?

In what publication (or publications) could I find the formulae known as "Leuschner's Short Method" of computing comet orbits?

"CENTAURUS."

ANSWERS.

44. COLOURS OF THE SPECTRUM.—The green part of the spectrum cannot be divided into yellow and blue; otherwise, as the querist suggests, the prism would fail to produce a green band. The only effect of using a prism to split up the green part would be to magnify that part, as it were, by showing more gradations of green.

The term "Primary Colour" does not mean "A colour incapable of analysis into others"; the "Primary Colours" are those sensations out of which all other colour-sensations are built, according to Helmholtz' theory. For instance, though yellow light may have a definite wave-length, when it strikes the retina three distinct sets of nerves respond, in such a proportion as to give the sensation of yellow. Other colours excite them simply in different proportions, and the colours which excite only one set of nerves at a time are called the Primaries. They are a certain red, green and blue. But, although *the sensation* of yellow is made up of a mixture of three sensations, it does not follow that yellow *light* can be split up into three differently coloured lights.

C. N. F.

44. COLOURS OF THE SPECTRUM.—The green region of the spectrum cannot be resolved into yellow and blue. Every part of a continuous spectrum has its own particular wave-length, and any very narrow portion of it may be considered as approximately monochromatic. The colours of the spectrum, when produced under proper conditions, (such as with a narrow slit, and so on), are pure; and it is important to distinguish clearly between such colours and the *subjective* tints which can be produced to imitate them by the proper blending of rays of other colours. On page ten of the new edition of Professor R. Wood's treatise "Physical Optics," there is the following reference to subjective colour: "The colour depends upon the wave-length, but colour cannot always be taken as an indication of wave-length, as certain colours can be imitated by the simultaneous action upon the retina of two trains of waves, *either of which acting alone would give rise to a totally different colour from that perceived when both act together.*" [The italics are mine]. "For example, a yellow scarcely distinguishable from the yellow of the sodium flame, can be produced by a mixture of red and green light in proper proportions."

CHARLES W. RAFFETY.

45. HEAT AND A VACUUM.—Heat can traverse a vacuum in the form of radiant heat, which has the property of being reflected by polished surfaces; thus the heat emitted from the inner vessel in a vacuum flask is sent back by the inner surface (polished) of the outer case; of course, some may be again reflected, back and forward, and it is to be remembered that at each reflection there is a slight loss; but at any rate, all the heat emitted is not lost, only that which is reflected an even number of times and then absorbed. If the space contained air, however, the conducting power of the air layer would carry heat to the case, give it up to the case, and so cause a continual loss.

C. N. F.

50. (3) RADIO-ACTIVITY.—It is generally considered that the glow ("luminescence") of the glow-worm is due to a process of oxidation. The light-giving organs consist of two layers. The inner one is of an opaque whiteness, and is possibly protective and reflecting; the outer is semi-transparent and of a slight yellow colour.

Between the two layers is a network of very fine trachae, which, it is presumed, supply the necessary air to the substances the oxidation of which results in the production of light.

The light of many Lampycidae, especially those out here, is *regularly* intermittent, *i.e.*, the light appears for, say, two flashes, and then ceases for the time of four flashes of equal duration; others are three to one: but the causal mechanism is, I believe, unknown.

L. G. GILPIN-BROWN.

50. RADIO-ACTIVITY.—(1) It is now accepted that the α particles emitted by radio-active elements are atoms of the gas helium. In the case of niton (radium emanation) this is capable of spectroscopic verification.

Such processes may be regarded as spontaneous transformations of substances which we have every reason to consider as elements.

(2) The X-rays and the γ rays from radio-active substances may be considered as closely similar types of radiation the actual nature of which is very uncertain. Many eminent physicists favour a pulse theory,—*i.e.*, one which supposes the radiation to be composed of very thin pulse-shells in which the wave-front is not uniform but nucleated; and that such pulses are due to the negative accelerations (X-rays), and the positive accelerations (γ rays) of swiftly moving electrons. Other investigators favour the view that both types are corpuscular, being composed of neutral pairs, and hence not deviated by magnetic or electrostatic fields. We may reasonably hope for more definite knowledge in the near future.

(3) The light of the "glow-worm" is believed to be due to the active oxidation of a peculiar photogenic substance produced by the insect. Experiments support this theory.

CHARLES W. RAFFETY.

REVIEWS.

CHEMISTRY.

Chemistry in the New Edition of the Encyclopaedia Britannica.

The requirements of an article upon a particular science in a general encyclopaedia are, firstly, that it shall be easily understood by an intelligent reader who is practically unacquainted with the subject; and secondly, that it shall contain a full bibliography to which the expert can refer for directions where to find what he wants. The chemist, for example, will not want to use the Encyclopaedia as a text book, while the average general reader will be repelled by pages of mathematical formulae which are appropriate enough in the text book. Any attempt to satisfy both classes of reader will inevitably fail to satisfy either.

Judged by this criterion, the new edition of the "Encyclopaedia Britannica," marks a great advance upon the previous edition. As instances of the way in which the chemical articles meet these requirements, we may cite those upon "Elements," "Colour" and "Fluorescence," which any educated person can follow. The general article upon "Chemistry," admirably written as it is, errs somewhat in the direction of the text book.

In most instances, the subject matter has been brought well up to date. For example, the latest details on metallography

are given, and excellent photomicrographs accompany the article on "Alloys."

It is, perhaps, in the biographical articles that the Encyclopaedia will fill the greatest gap in the library of the chemist. This portion of the work has been fully dealt with, and in a manner that leaves little to be desired.

C. A. M.

GEOLOGY.

The Coast Scenery of North Devon.—By E. A. NEWELL ARBER, M.A. 261 pages. 63 plates. 11 figures. 2 maps. 9-in. × 6-in.

(J. M. Dent & Sons. Price 10/6 net.)

Mr. Arber is a distinguished palaeobotanist, but in the intervals of his researches has found time to write this fine monograph on an exceedingly interesting and beautiful portion of our coast. In an introduction the general geology of the area is described. The country is built of highly plicated slates, sandstones and shales of Devonian and Carboniferous age. Two types of cliff, the "flat-topped," and the "hog's back" are distinguished. Whilst the former represents the effect of sea-erosion on a flat tableland, the latter is far more complex, and its origin is left in doubt. One of the special features of the coast-line is the fine series of coastal waterfalls, which are naturally most conspicuous when falling over the "flat-topped" type of cliff. An excellent section on "beach-scrambling" gives one the impression that it is a sport quite as exciting, if not as dangerous, as mountaineering.

Part 1 describes in detail the six districts into which the coast-line is divided. For each district full directions are given as to suitable headquarters, ways of reaching the cliffs, and the necessary maps. Part 2 deals with the special features of geological interest along the coast. The somewhat neglected subjects of the marine erosion of folded rocks, the evolution of coastal waterfalls, and sea-dissected valleys, are dealt with, and the author claims, and claims justly, original value for his work. This part forms a valuable contribution to the study of scenery. Mr. Arber shows that the intersection of the plane of marine erosion with a maturely dissected country must result in headlands and bays—the former corresponding to the watersheds, and the latter to the valleys—which have no relation to the differential hardness of the rocks involved. Whilst the latter may sometimes control the larger features of a coast, as in Pembrokeshire, more usually it merely determines minor irregularities.

A good bibliography and index is given, and the book is illustrated by a series of fine plates. The reader may be perplexed by the absence in some of the plates of any means of estimating the scale of the view shown. The author is to be congratulated on this book, which will be useful to both geologist and geographer. The best compliment we can pay it is to hope that it may be the precursor and model of many similar works.

G. W. T.

METEOROLOGY.

British Rainfall, 1910.—Edited by HUGH ROBERT MILL, *Director of the British Rainfall Organization.* 440 pages. 65 maps and illustrations. 8¾-in. × 5½-in.

(E. Stanford. Price 10/-.)

The British Rainfall Organization is an organization of voluntary and unpaid observers of Rainfall, nearly five thousand in number, resident in all parts of the British Isles. The work was established by the late G. J. Symons, F.R.S., and it is being ably carried on by his successor, Dr. Mill.

The volume for 1910 is the fiftieth of the series, and it is interesting to note that four of the observers who contributed to the first volume in 1861, also contribute to the volume for 1910. The volume for 1861 contained records from four hundred and seventy-one stations, that for 1910 contains records from four thousand eight hundred and seventy four stations.

Although primarily a volume of statistics the book will prove of great interest to very many who care but little for figures. The excellent maps which illustrate the distribution of rainfall over the United Kingdom, both in time and in space; the observers' notes upon exceptional weather experienced by them, and the discussion of heavy falls of rain, hail and snow, should prove interesting to all. Dr. Mill contributes an article upon "The Rain Gauge in Theory and Practice," which is probably the final word upon the subject.

In addition to yearly results for nearly five thousand stations there are monthly tables for three hundred carefully selected representative stations, and daily values for ten stations.

The Rainfall for 1910 varied between 19·44 inches at Ropner Park, Durham, and 187·06 inches at Llyn Llydaw Copper Mill, Carnarvonshire.

J. A. C.

NATURE STUDY.

Garden and Playground Nature Study.—By J. EATON FEASEY. 184 pages. 65 illustrations. 5-in. × 7¼-in.

(Sir Isaac Pitman and Sons. Price 2/6 net.)

Mr. Feasey has already produced two volumes dealing with school work that should be done in the open air, but in his introduction he expresses the conviction that the work and methods advocated in the present volume will be more valuable even than the set lessons which were contained in the others, and will surpass them from the point of view of real education. He quite rightly emphasises the fact that Nature Study should not deal merely with animals and plants. His first lesson, entitled, "A Trap to Catch a Sunbeam," is a comparison between two thermometers, one of which is kept under a bell jar. The lessons on dew, shadows, and the laws of reflection, as well as those on the weathercock and on snow, follow out the same idea; but "bloom," "the sleeping and waking of plants," and on "being irritable" deal with the botanical side of Nature. Many of the illustrations are good and it is obvious that they have been made on purpose for the book. Mr. Feasey goes into considerable detail as to how the lessons are carried out, and we may say at once that every teacher of Nature Study will gain something by reading this book.

W. M. W.

PHYSICS.

The Radiation Theory of Light and Color.—By Mrs. A. ROGERS-MOORE. 78 pages. 21 illustrations. 9½-in. × 6-in.

(U.S.A. The Stratton Press, Inc.)

A refutation of the Composite Light Theory of Newton. "To refute the Composite Theory, declared itself as the last necessity, not as incentive of color expression in nature. . . . The radiation theory has been evolved from the single desire to know the cause of the pink petal of a rose. . . . The work ended with a refutation of the Composite Theory as we have stated. . . . Let no condition of sunlight be lost therefore; if possible, let the observations be continued for years; as these have been to establish the Radiation Theory of Light and Color Formation."

Such is an extract from the Preface. It appeared promising! Later on: "Light and Color are the result of molecular motion of the air. . . . Light is the greatest air velocity which the eye recognizes. . . The spectrum is not any more spectral than any other colors and is just as natural." Finally: "It does not seem too much to assume that light rotates and pushes all ether and all the constituent parts of the air. In other words: the sun creates the world and everything on it. But not without a guiding hand."

I think after these quotations from the pamphlet a review is not of further necessity.

A. C. E.

ORNITHOLOGY.

The Young Ornithologist: A guide to the haunts, homes and habits of British Birds.—By W. PERCIVAL WESTELL, F.L.S., M.B.O.U., Author of "The Young Naturalist," "The

Young Botanist." 311 pages. With a frontispiece in colour, and sixty-five photographic illustrations. 7¾-in. × 5-in.

(Methuen and Co. Price 5/-.)

The title expresses the intention of this book, and the author writes with abundant vivacity and vigour. Young readers will find him to be a sympathetic and friendly adviser. For their edification he has "mapped out" the birds described according to their natural haunts, and this is put forward as the chief feature of the book. There are chapters on the birds of the garden, the country lane, the woodland, the waterside and so on. Such a division is fairly useful, and can be understood, but it is so far from being definite that it may be doubted if it is of any great value. No animals are less circumscribed in their bounds than birds and any arbitrary division is sure to require much explanation and qualification. Many species vary their habitats; this is illustrated, for instance, by Mr. Westell placing the Common Curlew and the Whimbrel both in the chapter on the birds of the moor and in that on the sea-shore. Correctly so: and this double-placing might have been extended to other birds also. The arrangement chosen makes queer neighbours, *e.g.*, the Woodlark is immediately followed by the Partridge and the Quail by the Stone Curlew.

Plenty of information and vivid descriptions are given of the different species, and the style of writing is certainly likely to prove more attractive to young readers than to others. Occasionally the author allows himself to lapse into errors such as occur when he speaks of the Brambling (page 168) as nesting in the British Isles, and the Snow Bunting (page 224), as breeding in England; and the statement that the Gannet breeds on "several groups of islands on our western shores" (page 271) is a generalization that requires serious qualification. On the other hand, the Fulmar Petrel (page 286) is not now restricted to St. Kilda and the Shetlands, having recently considerably extended its breeding range, and the Little Bittern (page 243), like the Common Bittern, nested in England at one time. The bird figured in the coloured frontispiece by Mr. G. E. Lodge, as the "Bittern at Home" is referred to in the text (page 242) as the Little Bittern; but it seems clearly to represent the Common Bittern. The remark that one hundred and thirty Heronries are still in existence (page 242) is not said to apply to England only, but in Ireland more than three hundred Heronries are known, and in Scotland about two hundred and twenty, at present. The photographs throughout the book are excellent, more particularly when their necessarily small scale is considered.

The first part of the work (and it perhaps ought to have been mentioned first here) is by Mr. A. R. Horwood, of Leicester Museum, running to seventy-eight pages, entitled, "Hints for the Young Ornithologist," on observing birds, collecting, field work, and so on. This is an admirable and thorough production, and the bird-boy who can assimilate these hints and act upon them, will approach perfection. He will demonstrate that, while the interests of the British boy (even in bird-nesting) are of more importance than those of the British bird, yet the bird, too, has its rights, which should be fully respected.

H. B. W.

FLIGHT AND FLYING IN THE "ENCYCLOPAEDIA BRITANNICA."

The article under this heading is distinctly disappointing, and although the casual reader may find some pleasure in studying the investigations of Pettigrew, De Lucy, and others into the action of birds' wings, and so on, the modern student would rightly expect something more up-to-date in the latest edition of a work which claims to be abreast of the times.

Certainly there is some slight mention of the machines of the Wright Brothers and Santos Dumont, together with photographs of the Farman, Blériot, and Roe machines, but there is no description of these later, nor is there one word about the modern theory of Flying Machines, which, even after making allowances for the exigencies of publication of a large work, must have been very well advanced at the time the article was written.

In short, there is nothing in the article of the least possible use.

T. W. K. C.

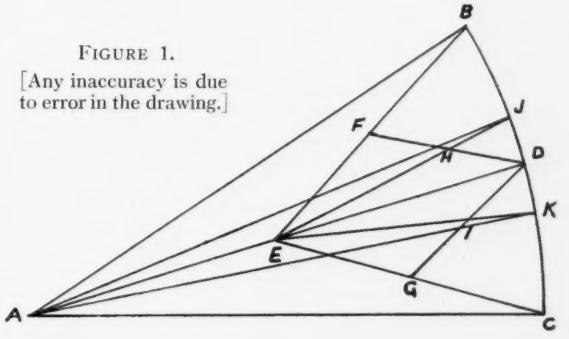
A METHOD (BELIEVED TO BE ORIGINAL) OF DIVIDING ANGLES OF 45° OR LESS INTO THREE EQUAL PARTS.

By C. S. BINGLEY, F.C.I.S.

Let B A C be the angle to be divided:
From the point A, mark or describe the arc B C
Bisect arc B C (D)
From D draw the line D A
Bisect line D A (E)
Draw lines E B; E C
Bisect lines E B; E C (F G)
Draw lines D F; D G
Bisect lines D F; D G (H I)

Draw lines E H; E I Continuing to J and K: the distances B J; J K; K C, will all be equal and, therefore, the arc B C divided into three equal parts, so that lines drawn from the points J and K to A (J A; K A) will divide the angle B A C into three equal angles, B A J; J A K; K A C

FIGURE 1.
[Any inaccuracy is due to error in the drawing.]



NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

FIGURE OF THE SUN.—*Bulletin Astronomique* for September contains an interesting article on this subject by Father Chevalier, S.J., of the Zo Se Observatory.

The investigation has been carried on by photography: only plates on which the limb is sharp have been used. A great many possible sources of error, such as imperfection in the refraction correction, deformation due to the objective, tilt of plate, diffraction, and so on, produced by the exposing slit, have been examined, and it is claimed that the precautions taken have practically eliminated their effects from the measures. The surprising result emerges that for the five years 1905 to 1909 the polar diameter of the Sun is longer than the equatorial one, the figures being as follows:—

Year.	Excess of Polar Diameter.	Probable Error.	Number of Plates.
1905	0″·07 ...	0″·05 ...	160
1906	0″·17 ...	0″·04 ...	278
1907	0″·31 ...	0″·03 ...	421
1908	0″·29 ...	0″·04 ...	320
1909	0″·13 ...	0″·02 ...	536

General Mean 0″·20, with Probable Error 0″·015.

It will be noted that in every year the Polar Diameter exceeds the Equatorial by an amount greater than the probable error. It is also noteworthy that there is a sort of sequence in the figures. The excess moves steadily up to a maximum in 1907, which is the year of sunspot maximum, and then steadily falls off. The results for 1910 confirm the falling off; ninety-six photographs taken in April and August give + 0″·05; one hundred and two in September and October give − 0″·05. There is certainly room for the suggestion that the sun's figure may change periodically in the sunspot period, which would be a result of great interest and significance. Dr. Chas. Lane Poor had already, in 1905, announced his suspicion of such a variation, from measures of photographs taken by Rutherford and Wilson. Father Chevalier is doubtful, however, whether the same precautions were taken in that series of photographs as in the present one, and is inclined to give it less weight. The fact of the Polar diameter exceeding the Equatorial one had been deduced by Dr. Auwers and MM. Schur and Ambronn. In fact, it appears that any long series of observations, however taken and however discussed, will yield this unexpected result.

MR. BARTRUM'S THIRD QUERY.—(August number, page 311).—The fallacy lies in considering the average value of r for equal time intervals. What we want to consider is the average value of disturbing force for equal time intervals. The Sun's whole action on the Moon varies inversely as the square of his distance, but his differential or perturbing action varies inversely as the cube of the distance. It can be shown that both the whole action and the differential action are greater for a more eccentric orbit of the Earth round the Sun. A simple geometrical proof for the whole action is given in Proctor's "Saturn and his System," First Edition, page 167. Consider two elliptical orbits with the same semi-major axis a, but with different semi-minor axes b, b^1, b being the greater. The periods (which depend on a) are equal. Let each planet be at the end of its minor axis, then each is distant a from the Sun. The areas of the orbits are as b to b^1, and this is also the ratio of the rate of description of areas, since the periods are equal. Now consider a very small interval of time from the moment when each planet is at the end of its minor axis. The small area swept out by each $=\frac{1}{2}\,a^2 \times$ angle swept out at Sun. Hence the angles swept out at Sun are as b to b^1. Now considering either planet at any point of its orbit, the gravitational attraction is $\frac{\mu}{r^2}$ and the sum of the action in time $t=\int \frac{\mu}{r^2}\,dt$. Also from the equal description of areas $dt=k\,d\,A$, where $d\,A$ denotes an element of area and k is a constant. And $dA=\frac{1}{2}\,r^2\,d\theta$ where $d\theta$ is the small angle swept out at the Sun in the interval dt. Hence the whole gravitational action in time

$$t=\int \frac{\mu}{r^2}\,k\,\tfrac{1}{2}\,r^2\,d\theta=\frac{\mu k}{2}\int d\theta=\frac{\mu\,k\,\theta}{2}.$$

Thus the action varies as the angle swept out. Now, returning to our two planets, the gravitational actions in the small interval of time considered are equal, since the distances from the Sun are equal. Thus action in whole revolution $=$ action in small interval $\times \frac{2\pi}{\text{small angle swept out.}}$ But we have seen that the small angles swept out in the interval are as b to b^1; hence the gravitational actions in the whole revolution are as b^1 to b, or the action is greatest in the planet with smallest b or greatest eccentricity. Hence, as the earth's orbit becomes less eccentric, the total action of the Sun on the Moon diminishes. The differential action diminishes also. For this

$$=\int \frac{k'}{r^3}\,dt \qquad =\int \frac{k'}{r}\,\frac{dt}{r^2} \qquad =\int \frac{k''}{r}\,d\theta$$

(k′, k″ denote constants). Now in an ellipse $r=\frac{a\,(1-e^2)}{1+e\,\cos\,\theta}$

$$\text{hence}\int \frac{k''}{r}\,d\theta=\int \frac{k''\,(1+e\,\cos\,\theta)}{a\,(1-e^2)}\,d\theta=\frac{k''\,\theta}{a\,(1-e^2)}+\frac{k''\,e}{a\,(1-e^2)}\int \cos\,\theta\,d\,\theta.$$

Now, on integrating through four right angles the second term vanishes and the total differential action of the Sun in a year $=\frac{2\,k''\,\pi}{a\,(1-e^2)}$. As e diminishes this action also diminishes, and the Moon approaches the earth and moves faster.

COMET NOTES.—Brooks' Comet will be a morning star in November, but not very easy to see, owing to its approach to the sun.

The following is an ephemeris for 11 p.m.:—

	R.A. H. M. S.	S.Dec.		R.A. H. M. S.	S.Dec.
Nov.	4...12 37 43	4° 57′	Nov.	16...13 0 17	18° 3′
,,	8...12 43 56	9° 49′	,,	20...13 9 45	21° 28′
,,	12...12 51 38	14° 10′			

Two other comets were discovered at the end of September that of Quenisset was of magnitude 7, thus being an easy telescopic object; that of Beljawsky would have been a very fine object on a dark sky, but it could only be seen low down in the twilight. Neither comet will be well placed for observation in November, so we simply give elements without ephemerides.

	Quenisset.	Beljawsky.
T	1911, Nov. 12·67 (Berlin)	1911, Oct. 10·30 (Berlin)
ω	123° 24′	71° 39′
Ω	35° 37′	88° 44′
ι	108° 23′	96° 38′
Log q.	9·8897	9·4823

The orbit of Quenisset is very like that of Comet 1790 III., discovered by Caroline Herschel.

THE NEW FRENCH TABLES OF THE MOON.—The appearance of new lunar tables is an important epoch in exact astronomy. It is about half a century since the appearance

of Hansen's tables, which were an immense improvement on all that preceded them; they were considered, in the words of Sir John Herschel, "As a practical completion of the lunar theory, at least for the present age, and as establishing the entire dominion of the Newtonian theory and its analytical application over that refractory satellite." These high expectations were doomed to some disappointment; in a few years the errors of the new tables became serious; an examination of the cause was made by Professor Newcomb; he found that the main part of the error was due to Hansen's Venus terms; the one of two hundred and thirty-nine years period should be omitted altogether, and that of two hundred and seventy-three years seemed to need an alteration of phase. Newcomb further reduced the secular acceleration from 12″·18 to 8″·42. Hansen supposed he was using the theoretical value, and also that indicated by ancient eclipses, but Adams showed that the value really given by theory was only 6″, and a more careful study of the eclipses showed that they were better represented by 8″ or 9″. Newcomb further showed that in consequence of his changes the motion of the moon in a century must be reduced by 29″·17. His correction to the two hundred and seventy-three year term was an empirical one (this expression denotes a term derived from observation alone, without any known basis in theory). It had a coëfficient of 15½″ and a period of two hundred and seventy-three years like the Venus term. All who have studied the moon's motion have found the need for such a term, though they differ about its exact size and period. Newcomb's corrections, which were introduced in the *Nautical Almanac* in 1883, were a great improvement on Hansen; the objection that some people made that they introduced empiricism into astronomy was not a fair one; Hansen's tables were themselves empirical as regards the erroneous Venus term, which has no basis in theory; three of Newcomb's four corrections brought Hansen nearer theory than before, only the fourth was empirical. In recent years the moon's place has begun to deviate considerably from Hansen corrected by Newcomb, so the need of new tables has been felt. The great French astronomer Delaunay was engaged on his lunar researches at the same time as Hansen, but in a different manner. His idea was to find algebraical expressions for all the terms as functions of the elements of the solar and lunar orbits. The advantage is that the effect of a change in the adopted value of any element can at once be deduced, also that the investigation serves for other satellites, provided their eccentricities and inclinations are not too great (they break down for the new satellites of Jupiter and Saturn). The drawback is that the expressions do not converge rapidly, and that even after computing a very large number of terms, he had reason to fear that those of higher orders were still sensible. Delaunay was unhappily drowned at Cherbourg in 1872, when the theoretical work was nearly completed, but the preparation of tables scarcely begun. These long remained in abeyance, till the Bureau des Longitudes took up the matter, and it has now been concluded with the help of the late Professor Tisserand, MM. Schulhof, Andoyer and others. It is not a blind following of Delaunay, whether right or wrong, but advantage has been taken of the work of Radau, Brown, Cowell, and others, to correct and supplement those terms that seemed to be defective, if necessary carrying Delaunay's developments to a further approximation; this has been done chiefly by M. Andoyer. The new tables diminish Hansen's mean motion by 27″ per century, and his acceleration by 4″·48, making it 7″·7. Instead of Newcomb's empirical term of two hundred and seventy-three years, they introduce the following two empirical terms:

$+11''\cdot5 \cos [1°\cdot37\ (t-1790\cdot5)]$. Period 263 years.
$+\ 3''\cdot3 \cos [5°\cdot6\ \ (t-1856\cdot5)]$. Period 64·3 years.

They make an interesting suggestion as to the possible origin of these terms: "Consider a swarm of tiny planets circulating round the sun at a distance about 0·178, period 27·3 days, almost the same as that of the moon. If the total mass of the swarm was one-fifteenth of that of Mercury, that is one-third of that of the moon, there would result a term in the moon's longitude with coëfficient 12″, period two hundred and seventy years." Other positions of planets are also given which might produce such a result. It is a striking instance of the possible importance of small masses when their periods are almost commensurable with other periods. It will probably be of general interest to note the arithmetical values of the more important terms in the new tables and the corresponding values found by Cowell from an analysis of the Greenwich observations; the latter is denoted by C. For the Evection they use 4586″·32, C. 4586″·4; variation 2369″·95, C. 2370″·2; Principal Elliptic Term 22639″·75, C. 22639″·5; Annual Equation −668″·92, C. −668″·2; Parallactic inequality −125″·10, C. −124″·9. For a geometrical explanation of these terms the reader is referred to Proctor's "Moon," or to "KNOWLEDGE" for March, 1903. For the mean parallax they use 3422″·70, agreeing well with Newcomb's gravitational value 3422″·68; Hansen's value was 3422″·24; for the mean semi-diameter they use 933″·60, which is half a second less than Hansen, and exactly agrees with Cowell's value deduced from fifty years of Greenwich observations; Hansen's value is evidently too great; even the new one is one second greater than the value obtained from occultations, the difference being due to irradiation, which causes all bright bodies to be measured a little too large. On the whole the new tables are a great improvement on Hansen's, and the only doubt about their utility is due to the fact that Brown's tables are nearly ready, and will probably be still more exact than these. However, there are some advantages in having two reliable tables; sometimes small errors are picked up by comparing them; thus a small error in Newcomb's Mars tables was found by comparison with Leverrier's tables, which are still used by the Connaissance des Temps; I presume that it will use the new lunar tables, starting with the year 1914.

ERRATA IN LAST MONTH'S NOTES.—Two points in last month's notes need correction. The diagram showing the change of period of Encke's comet was printed upside down. It is now repeated correctly. Secondly, in the list of dates of observations of the satellites of Mars, one accidentally dropped out. The list is therefore repeated; the dates for

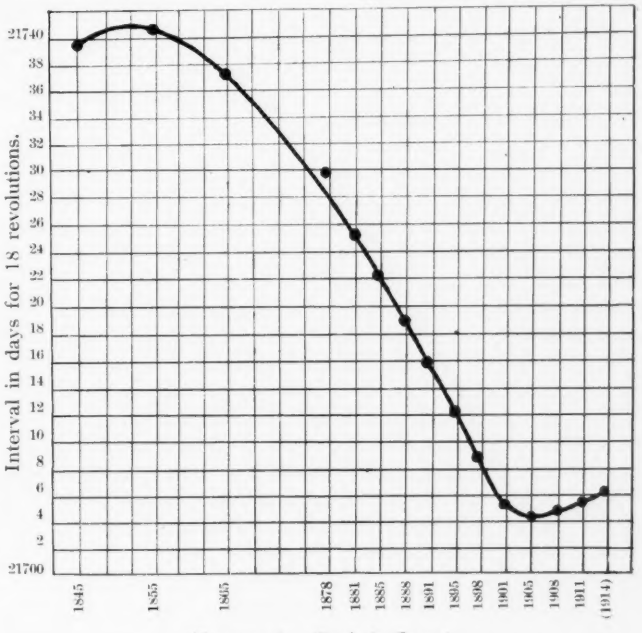


FIGURE 1. Encke's Comet.

Deimos are 1877·7, 1879·9, 1886·2, 1892·6, 1894·8, 1896·9, 1907·5. For Phobos 1877·7, 1879·9, 1892·6, 1894·7, 1894·8, 1896·9, 1907·5.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

PAPERS ON ECOLOGY.—Two of the Continental botanists contributed papers, both on Ecology. Prof. Schröter described in an interesting fashion "The Swiss National Park and its Flora," giving an account of the admirable and extensive operations of local Committees, assisted by the Federal Government, in the useful work of conserving the natural features of various parts of Switzerland and protecting the native flora from extinction. Prof. Massart described, under the title "Phytogeography as an Experimental Science," various methods and results of experiments in which plants were grown under conditions strikingly different from their natural habitats.

Professor Cowles described his observations on advancing sand-dunes in Michigan, which he has studied for about fifteen years. The dunes are of gigantic size, the advancing front having an altitude of twenty-five to sixty-five metres above the country in the path of advance. So high are the dunes and so great their rapidity of movement, that very few of the overtaken plants are able to survive. Curiously, the plants able to endure partial burial by these dunes are not xerophytes, like the pines and oaks, but swamp plants and mesophytes, such as species of *Salix* (Willow), *Populus* (Poplar), and *Cornus;* the shrubby plants are stimulated by the advance of the sand to extraordinary elongation of their stems. Survival depends upon the capacity of a plant to put forth new roots and to elongate as rapidly as the dune advances. In some places there are Elms thirty metres in height, above the original country level, with the tree tops projecting only one or two metres above the sand, yet their foliage is healthy and they flower and fruit vigorously.

Miss Sarah Baker, dealing with "The Brown Seaweeds of a Salt Marsh," stated that the capability of giving rise to marsh forms seems to be shared by all the brown seaweeds inhabiting the upper parts of rocky shores. *Pelvetia canaliculata*, *Fucus spiralis*, *Ascophyllum nodosum*, and *Fucus vesiculosus*, all show marsh varieties or species. The reason that *Fucus serratus* and *F. ceranoides* have no representatives in the marsh habitat is probably their intolerance of desiccation. The physical and chemical environment factors on the marsh being much more complex and varied than on a rocky shore, one would expect a corresponding variation in the structure of its plants. The most marked characteristics of the common marsh species are a great tendency to spiral twisting or curling of the thallus—and vegetative reproduction. That this latter feature is not directly caused by the marsh habitat is shown by exceptional species where reproduction is normal. The zoning between the brown seaweeds of a marsh is often very striking; but the factors governing it must be far more complicated than those operating on the seashore. The extensive mattings of brown seaweeds often found on English marshes have a decidedly beneficial effect on the Phanerogams. It seems possible that *F. volubilis* may act as a pioneer in the establishment of salt marshes in certain cases.

Mr. W. B. Crump contributed two interesting and detailed papers on "The Water Content of Acidic Peats" and "The Wilting of Moorland Plants." These two papers, somewhat too lengthy to be reproduced here, and too condensed to be readily summarised, represent an earnest attempt to fill a decided gap in ecological literature and to supply exact data, based on quantitative experimental work, regarding the water-content, humus content, and mineral content of the soil on moorlands, and the percentages of available soil-water for different plants. Much work of a similar kind has been done with arable soils, but it is important to have as much knowledge as possible concerning the physical and chemical characters of economically barren soils, in order to be able to deal better with the problems of plant distribution.

Miss Lilian Baker and Mr. B. W. Baker, contributed a paper entitled "Types of Vegetation in the District around Macclesfield." The area under study comprises parts of Cheshire and Staffordshire, the four corners being roughly represented by the towns of Northwich, Crewe, Leek, and Macclesfield. It includes part of (1) the Cheshire Plain, largely cultivated, with numerous parks and wooded estates, and a few sandy heaths and "mosses"; and (2) the Pennine Foothills consisting of approximately parallel ridges intersected by the Dane valley and other wooded ravines and covered by moors. The rainfall increases from the level western parts towards the hilly east. The two regions show marked geological differences; the plain consists of triassic rocks buried in Pleistocene times under a thick covering of glacial deposits, while the hill region consists of carboniferous rocks. Peat-mosses occur on the plain in the position of former glacial lakes, but have been largely reclaimed. The chief Associations described are (1) Moorland and Heath; (2) Grassland, represented by heath pastures; (3) Woodland; (4) Aquatic, and (5) Pasturage.

Prof. Oliver gave an account of "The Life History of a Pebble Beach," and Prof. Yapp discussed "The Causes of the Formation of Hairs and Palisade Cells in certain Plants," but no printed resumé is available in either case; probably the results will be published in botanical periodicals sooner or later, when they will be noted here. The same remark applies to a paper read by Dr. F. J. Lewis on "The Forest Stages represented in the Peat underlying the Moorlands of Great Britain."

Some interesting points were raised by Mr. C. Reid, in his paper on "The Relation of the Present Plant Population of the British Isles to the Glacial Period." A century ago it was generally supposed that species had originated mainly in the districts in which they were then found; but this presented the obvious difficulty that the same species was not likely to have originated at several different points, hence the anomalies of discontinuous distribution were left unexplained, and with the growth of the idea of evolution it was realised that faunas and floras had a past history, even if the included species had remained unchanged, and botanists realised that there were many further points requiring explanation. For instance, it was early noticed that each of our mountain tops possessed a small outlying fragment of the arctic flora; how, then, came it that the same species occupied so many different mountains? About sixty years ago, Edward Forbes seized the clue afforded by the discovery of the Glacial Period, and explained the arctic plants stranded on our mountain tops as relics of this Period—they were left behind when the climate became too warm for them to survive longer on the plains, and the subsequent discovery of fossil remains of these plants scattered over the plains, often associated with relics of arctic animals now extinct in Britain, seemed a brilliant proof of Forbes' view, which has been generally adopted.

But Forbes' hypothesis, granting that it explains our alpine flora, makes more difficult, rather than easier, the explanation of our southern flora, which occurs in a similar way, stranded in some of the warmest low-lying parts of Britain. This difficulty appears to have been generally overlooked. We must start with the assumption that we have merely to account for the incoming of our existing flora, after an earlier (Pre-glacial) assemblage had been swept away as completely and effectually as the celebrated volcanic eruption wiped out the plants of Krakatoa. None of our flowering plants, excepting a few arctic and alpine species, could possibly have survived and lived through the cold of the Glacial Period. We know that the same temperate species that live in Britain now were here in pre-Glacial times, hence they must have found a refuge somewhere, but this refuge cannot have been in Britain. During the greatest intensity of the cold all Scotland, Ireland, and the greater part of England were buried under ice and snow, except possibly for some high peaks on which a few arctic species survived; ice filled the North Sea and covered the lowlands of England down to the mouth of the Thames, its southern limit extending to South Wales, where tongues of

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ice reached the Bristol Channel, in big glaciers like those of the Antarctic or Greenland. The glaciation in Ireland was even more extreme, for no part escaped—even the warmest parts of the south-west are striated and covered by moraine material, the ice forming bergs so large that they floated to the Scilly Isles before melting. Obviously, no temperate plant could survive such conditions, and even if we consider the non-glaciated area south of the Severn and Thames, we find evidence of such cold as precludes the possibility of warm nooks in which the temperate flora may have survived.

If the southern plants were completely swept away by the cold, how did they come back again, especially to islands like Ireland and the Scilly Isles, and how did they obtain their present singular distribution? Before we adopt the view that for plants to spread to islands one must have land connection —Britain has often been connected with the Continent—one must remember the rapidity with which the exterminated flora of Krakatoa came back. Moreover, some peculiarities in our flora cannot be explained by land connection; for instance, the Pyrenean element in our flora is practically confined to Cornwall and the West of Ireland, but geologists nowadays will not agree to the reconstruction of a lost Atlantis to account for this peculiar distribution, since no likely elevation of the land would suffice to connect the areas mentioned.

Chance introductions of seeds during thousands of years explain the existing peculiarities of geographical distribution in a way that no changes of sea or land or climate will do. Our alpine flora consists largely of survivors from a colder period; but the rest of our flora is constantly being added to by chance introductions from the nearest continental shore—hence the Atlantic element and the Eastern element, though not consisting to any great extent of maritime plants, are confined mainly in Britain to areas within a few miles of the coast. Seeds are evidently brought from the Continent and scattered broadcast over certain coastal districts, and they grow and spread where soil and climate are suitable; but the post-Glacial period has been so short that the process is still incomplete, and the slow spreading inland has only as yet extended a few miles.

Mr. Reid concluded by stating his view that there is no such thing as a native plant in Britain. Our flora has been swept away like that of Krakatoa, but we have arrived at a much later stage in the re-peopling of our islands. "It seems to me far more interesting to watch this process of introduction, change and spreading, than to enter into speculations as to what species shall be listed as 'natives,' 'denizens,' or 'colonists.' No such differences exist; it is all a question of degree. Britain for several thousand years has been receiving colonists from all sources, and the process still goes on. The oldest element in our flora—the alpine—occurs on nearly all our mountains; for it once occupied the intervening areas, and it does not greatly depend on conditions of soil. The limestone, aquatic, and Lusitanian flora, on the other hand, are more recent introductions; they can never have occupied continuous areas, and their present distribution is full of singular anomalies. These three elements of our flora are steadily growing in importance, while the alpine element is stationary or tends to die out."

PAPERS ON PALAEOBOTANY.—Palaeobotany was well to the fore, figuring largely not only in the Presidential Address to the Section but also in the papers read.

In a paper entitled "A Palaeozoic Fern and its Relationships" (not actually read, owing to lack of time), Dr. D. H. Scott described a specimen of one of the simpler Palaeozoic Ferns (Primofilices of Arber, Coenopterideae of Seward), probably a new species of *Zygopteris* (*Z. Sutcliffii*). The stem of this new specimen has a five-rayed star-shaped stele, leaf-trace bundles with axillary shoots, scale-leaves (aphlebiae), and adventitious roots; the characteristic internal xylem, consisting of narrow tracheids embedded in parenchyma, is especially well shown both in the main stem and in the axillary stele. The leaf-trace is crescentic in section; the evidence of the new specimen favours the view that the large strand given off from the stele is really a leaf-trace and not itself a branch—the branch which the leaf-trace gives off higher up may therefore retain the name "axillary shoot" originally given it by Stenzel; the course of the aphlebia-strands, given off by the leaf-traces both before and after their separation from the stele, could be clearly followed.

Dr. Benson described "The Structure of a New Type of Synangium from the Calciferous Sandstone Beds of Pettycur, Fife, and its Bearing on the Origin of the Seed." This synangium, or chambered spore-case, is attributed to the Pteridosperm *Heterangium grievii*, and probably represents the pollen synangium of that plant. It differs from all hitherto described synangia in the variety and large proportion of its sterile tissue, which shows the sclerotic plates characteristic of the inner cortex of *Heterangium grievii*.

Numerous vascular bundles with hydathodal (water-gland-like) ends occur, and irregular longitudinal dehiscence was brought about by the swelling of hygroscopic fibres. Another wholly new feature is the occurrence of both central and peripheral loculi (four central and twelve peripheral). The loculi agree in size and form with those of the incrustation fossil, *Diplotheca stellata* (Kidston), which is identified as the same synangium in a dehisced phase. The discovery of the structure of this early synangium adds fresh confirmation to the synangial theory of the seed, which may be restated as follows: The Palaeozoic ovule of the Lagenostoma type may be regarded as the product of the elaboration of a synangium comparable to the above—the megaspore or embryo sac being derived from the central group of loculi, and the canopy and peripheral part of the ovule from the peripheral part of the synangium with its envelope, twelve loculi, cortical tissue, and vascular bundles.

Professor Seward read a preliminary account of his observations on a petrified Jurassic plant from Scotland, resembling *Bennettites* in some respects, but showing peculiar characters of its own, such as the presence of large quantities of filamentous hairs forming a packing between the bracts of the cone.

Mr. H. H. Thomas described some "Recent Researches of the Jurassic Plants of Yorkshire," from which it appears probable that some extremely interesting results may be expected. The paper gives a summary of some results already obtained by Nathorst, Halle and the writer. For instance, from material collected on the Yorkshire coast, Nathorst has recently discovered the male sporophylls of *Williamsonia*, which are joined into a cup-like structure somewhat comparable to a flower, and are covered with large sessile synangia from which the remains of the microspores (pollen-grains) can be extracted by treatment with acid; the female cone of *Williamsonia* closely resembles that in *Bennettites*, but the flowers were unisexual. Thomas recently found a new Bennettitalian flower which appears to be bisexual, like the American specimens of *Bennettites* (*Cycadeoidea*); the central axis bore the usual ovules and intraseminal scales, and below this there was a whorl of five or six large free sporophylls arranged like the petals of a hypogynous flower, each bearing five or six large kidney-shaped sporangia. Reference was also made to the discovery of small fruit-like bodies named by Mr. Thomas as *Caytonia*; they appear to contain the remains of about ten seeds, and similar isolated seeds have been found, some of the structure being preserved—e.g., integuments, micropylar tubes, and nucellus. Among various interesting Ferns there are forms allied to such modern genera as *Todea*, *Cyathea*, and *Marsilia*.

In a short paper, Miss Lockhart made a "Contribution to the Theory of the Formation of Calcareous Nodules containing Plant Remains." Three boulders from the Calciferous Sandstone of Pettycur were entirely cut into thin serial sections in the search for a minute object, and it was thus possible to trace the position, in a block, of any particular plant. *Metaclepsydropsis duplex* and *Botryopteris antiqua* were chosen, as they presented a contrast between a large and a small plant. The clear delimitation of even the smallest fragments points to mechanical fracture subsequent to immersion, and the parallel position of plant remains in the boulder further indicates the agency of water currents. The results confirm

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Dr. Gordon's views of thermal pools as the actual site of petrifaction.

PAPERS ON FUNGI AND BACTERIA.—Mr. A. S. Horne described the nuclear divisions which occur in a Fungus parasitic on the Potato, *Spongospora solani*, a member of the lowly group Plasmodiophoraceae. Several other genera of this group were also dealt with by Mr. T. G. B. Osborn in a paper entitled, "The Life Cycle and Affinities of the Plasmodiophoraceae." Without entering into the technical details of nuclear division described in these papers, it may be stated that the observations made tend to strengthen the suggested relationship of this group to the Slime-Fungi (Myxomycetes) and possibly also with the Chytridiaceae. In *Spongospora solani*, Horne describes a very curious form of nuclear division, in which four loop-like chromosomes appears and later join end to end to form an equatorial ring around the nucleolus; this ring divides into two daughter rings, each of which finally breaks up again into four chromosomes, while the nucleolus constricts to form two daughter nucleoli.

Professor Bottomley described the structure and function of the root-nodules of the bog myrtle (*Myrica gale*) which are formed as modifications of normal lateral roots, these branching and forming clusters covered with rootlets growing out through the end of each nodule or branch—the branching is due to the outgrowth of lateral roots, and not to forking of the apex of the primary nodule, as in the nodules of *Cycas*, Alder and *Elaeagnus*. The cortex of a young nodule contains (*a*) numerous cells with bacteria, and (*b*) cells filled with oil drops; towards the apex of the nodule the infection threads can be seen passing from cell to cell, and the whole nodule is covered by two or three layers of cork cells. Pure cultures of the bacteria show small rod-like bodies resembling *Pseudomonas radicicola*, the organism found in all Leguminous nodules, and giving a definite fixation of nitrogen when grown in flasks. Young *Myrica* plants grown in pots in soil deficient in nitrogen flourished well if possessing nodules; if without nodules on their roots they soon died. Evidently the nodules of Myrica are concerned with the assimilation of atmospheric nitrogen, as are the root-nodules of *Cycas*, Alder, *Elaeagnus* and *Podocarpus*, the other known genera of plants outside of the Leguminosae which have root-nodules.

PAPERS ON PHYSIOLOGY. — Professor Bottomley described "Some Effects of Bacteriotoxins on the Germination and Growth of Plants," illustrated by some remarkable photographs of comparative cultures. An aqueous extract of well rotted manure or fertile soil, obtained by treating one hundred grammes of manure or soil with five hundred cubic centimetres of isotonic salt solution and filtering through a Pukall filter, has an injurious effect on the germination of seeds and their further growth in sand, even when supplied with normal food solution. This inhibitory effect of the extract can be destroyed by boiling. The harmful effect is due to the presence of certain bacteriotoxins, probably of the nature of toxalbumoses, formed by the activities of the decomposition and denitrifying bacteria in the manure or the soil, and by heating the toxic influence is destroyed and the substance rendered available as a nutrient.

Experiments with germinating seeds of mustard, turnip, tares, and barley give support to this theory. Seeds germinated in pots containing sand moistened with (*a*) distilled water, (*b*) saline solution, (*c*) raw extract, (*d*) boiled extract, showed that the raw extract almost prevented germination and the subsequent growth was very feeble, whilst the boiled extract, although slightly retarding germination at first, soon appeared to benefit the seedlings which became stronger and healthier than those grown without extract. The extract was also found to have a marked influence on the growth of certain soil organisms. It stimulated the growth of denitrifying bacteria, and inhibited the growth of the nitrogen-fixing bacteria. Both these effects were destroyed by boiling the extract.

Mr. S. Mangham, who has already done useful and interesting work on the translocation of carbohydrates in plants, described some of his observations on the presence of sugar in the tissues of the Sea Tangle, *Laminaria*. The two species *L. digitata* and *L. saccharina* were examined for sugars at various times of year by means of Senft's method of forming osazones. Observations were made upon sections cut from the stipe, the region of new growth, and from the lamina. Crystalline osazones have been found in the cortical cells, the sieve-tubes, and the hyphae in both species, and particularly at the time of formation of the new lamina in *L. digitata*. Some of the crystals in the latter plant very closely resemble those yielded by maltose, but their exact identity is at present unknown. This production of osazones in the hyphae and in the sieve-tubes after treatment with Senft's reägent affords experimental evidence in support of the conducting and storing function hitherto assigned to these elements mainly on account of their structure.

Miss Fraser described in detail "The Longitudinal Fission of the Meiotic Chromosomes in *Vicia Faba*."

Dr. A. A. Lawson, in a paper on "Nuclear Osmosis as a Factor in Mitosis," put forward views which run counter to some generally accepted interpretations of the phenomena of nuclear division, and which are likely to lead to further discussion. Dr. Lawson claims to have discovered that the nuclear membrane does not break down or collapse at any period, but behaves as one would expect a permeable plasmatic membrane to behave under varying osmotic conditions; and that the achromatic spindle can no longer be regarded as an active factor in mitosis, but is simply the passive effect or expression of a state of tension set up in the cytoplasm and caused in the first place by nuclear osmotic changes.

Miss L. Digby gave a preliminary account of the cytology of the hybrid *Primula kewensis*, its parents, and the ensuing generation. The original *P. kewensis* appeared in a pure batch of *P. floribunda* seedlings at Kew in 1899, and proved to be a cross between *P. floribunda* and *P. verticillata*. The hybrid was sterile, with only thrum-eyed flowers, but some years later a single pin-eyed flower was noticed in Veitch's nurseries. This was promptly fertilised, good seed was set, and the resulting plants had both pin-eyed and thrum-eyed flowers and were fertile. Thus the whole fertile or seedling stock of *P. kewensis* owes its origin to the one pin-eyed flower on the sterile or type stock of *P. kewensis*.

The parents of *P. kewensis* (sterile) have identically the same number of chromosomes, and (as might be expected) this number is repeated in the hybrid: *P. floribunda*, *P. verticillata*, and *P. kewensis* (sterile) all have eighteen (2x) and nine (x) chromosomes. The surprising phenomenon occurs in the seedling *P. kewensis*, in which there are thirty-six (2x) and eighteen (x) chromosomes. By some means either at, or subsequent to, the fertilisation of the pin-eyed flower on the sterile stock the number of chromosomes has been duplicated; this doubled number is continued throughout the generations of the fertile *P. kewensis*, and is also characteristic of the variety *P. kewensis farinosa*. This increase cannot be accounted for by apogamy; the divisions in the embryo sac mother nuclei of both sterile and fertile forms are normal, and in the one case nine (x) and in the other eighteen (x) chromosomes are seen at meiosis, while in the surrounding tissue there are correspondingly eighteen (2x) and thirty-six (2x) chromosomes. The doubled number of chromosomes has since re-appeared in a cross made in 1910, at Kew between *P. floribunda* var. *isabellina* and *P. verticillata*; the resulting hybrids not only resemble *P. kewensis farinosa* in external features, but also possess thirty-six (2x) chromosomes.

This remarkable sudden duplication of chromosomes has its counterpart in the Oenotheras. *Oe. Lamarckiana* has fourteen (2x) and seven (x), while *Oe. gigas* which mutated from *Oe. Lamarckiana* has twenty-eight and fourteen. Like the fertile *P. kewensis*, *Oe. gigas* has again arisen from two sources—once as a hybrid and once from a pure strain of *Oe. sublinervis*. In the Oenotheras, as there is no evidence of the addition of new unit characters, the doubling of the chromosomes is believed to be brought about by longitudinal fission. In the Primulas the phenomenon is apparently associated with the change from the sterile to the fertile condition.

When *P. floribunda* var. *isabellina*, with its eighteen and nine chromosomes, is crossed with *P. kewensis* seedling form, with its thirty-six and eighteen, the offspring resemble the seed-parent (*P. floribunda* var. *isabellina*) both in external characters and in number of chromosomes. By some regulating process the sum of 9 (x)+18 (x)=18 (2x). Again an analogy is found in the Oenotheras, for *Oe. lata* (fourteen and seven chromosomes), crossed with *Oe. gigas* (twenty-eight and fourteen chromosomes), results in a hybrid with twenty-one (2x) chromosomes; according to Geerts, at meiosis the seven homologous chromosomes derived from either parent become paired, while the seven supernumerary unpaired chromosomes disintegrate, and in this way the x number of chromosomes in the hybrid is reduced to that of the parent which possesses the lowest number.

MISCELLANEOUS PAPERS.—Miss Kershaw described the ovule of *Bowenia spectabilis*, which agrees on the whole with other genera of Cycads. The pollen chamber of *Bowenia* forms by the breaking down of a strand of elongated cells, extending from the tip of the nucellus almost to the megaspore. First a small cavity (upper chamber) forms in the narrow apex of the nucellus, and this probably accommodates the pollen when it enters the ovule. The nucellar tissue below gradually breaks down, forming a larger cavity (lower chamber), into which the pollen grains pass from the upper chamber. The upper and lower chambers correspond in function with the lagenostome and plinth of such fossil seeds as *Conostoma*, but are much less specialised than the corresponding structures in the Lagenostomales.

Mr. Horne discussed "The Polyphyletic Origin of Cornaceae," giving the results of detailed study of the flower of several genera of this order, together with comparative study of the effects brought about by progressive sterilisation and reduction in the ovary of the Caprifoliaceae, Hamamelidaceae, and Araliaceae. In the Caprifoliaceae every intermediate stage may be found between ovaries of the *Leycesteria* type (double rows of ovules in each chamber) and uniovular ovaries (*Viburnum*); progressive reduction trends to the uniovular condition, but each genus pursues an independent course of development towards this condition. In the Cornaceae, the flowers possess certain resemblances, *e.g.*, polypetaly and epigyny, while the ovaries or loculi in some genera are uniovular with terminal ovules, but they possess peculiarities in (*a*) structure of ovary (*Cornus*); (*b*) vascular supply of ovary (*Garrya*); (*c*) vascular supply to ovule (*Griselinia*); (*d*) form of ovule (*Davidia*); (*e*) structure of nucellus (*Aucuba*); and so on. It is suggested that these peculiarities indicate different origins; the general resemblances in structure do not appear to be of any considerable value in establishing close relationships in the order, but are to be regarded as striking parallelisms brought about by the operation of similar evolutionary processes upon distantly related forms.

During the Portsmouth meeting, a semi-popular lecture was delivered by Dr. F. Darwin on "The Balance Sheet of a Plant"; while one of the evening discourses was given by Professor Seward, his subject being "Links with the Past in the Plant World."

Two interesting Excursions were made by the Botany Section, one to the New Forest to study especially the heath vegetation, the other in a steam launch up Southampton Water for the estuarine vegetation, and especially the *Spartina* grasses.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON.), F.I.C.

NATURAL GAS IN GALICIA.—Dr. K. Feldmann, writing in *Petroleum* (1911. VI, 2232), gives an interesting account of the steps recently taken to utilise the natural gas emitted from the borings for petroleum oil in the Boryslaw-Tustanowice oil-fields. Until about two years ago this gas was, for the most part, allowed to escape into the air, only a small proportion being used for heating and power purposes upon the spot. Recently, however, a pipe-line has been constructed for conveying the superfluous gas to Drohobycz, a distance of over eight kilometres, where it is intended to utilise it in the oil-refineries and for distribution in the town.

The gas issuing from the borings is colourless, and has a specific gravity of about 0·75 and an average heating capacity of about 10,835 calories per cubic metre. Two typical samples from different borings contained 8·7 and 8·8 per cent. of heavy hydrocarbons; 86·5 and 83·1 per cent. of light hydrocarbons; 1·0 and 1·7 per cent. of oxygen; and 3·8 and 6·4 per cent. of nitrogen (corresponding to 5 and 8 per cent. of air) respectively.

The various pipes conducting the gas from the different borings come together at Kamilla, and it is intended to establish a central power station at that point. Here the gas is freed from moisture, and passes through an apparatus which records the percentage of air, this precaution being taken to prevent an explosive mixture (one containing over 10 per cent. of air) being distributed. As the gas is poisonous a small addition of mercaptan is also made at this stage, in order to render any escape perceptible by its odour.

The main pipe is constructed of steel tubes which have been tested in the works up to a pressure of ten atmospheres, and these are coated with a layer of jute surrounded within the trench with tar and lead. The finished pipe line is tested up to a pressure of four atmospheres, although the maximum pressure at which the gas is driven through it does not exceed 1·8 atmospheres.

BOLOGNA LUMINOUS STONES.—Lémery in his "Treatise of Chymistry," published in 1720, in a section upon the Bolonian Stone, describes it as "a small gray stone, weighty but soft, sulphureous, sparkling in many Places, of the Largeness of a Walnut, whose Surface is not equal but bunchy and protuberant and the opposite side is hollow. Large Stones are only valuable for their Rariety; for they are not so good to make the *Phosphorus*, because commonly they are opaceous; the small ones are much better, they shine more and have fewer Blemishes." According to Lémery the nature of the phosphorescence was investigated by an Italian who "did particularly apply himself to this Discovery, and he made great Progress in it. But it does not appear that he did communicate the same to any Body, so that the secret has been buried with himself many years ago."

Since the days of Lémery the phosphorescent stones of Bologna have frequently been examined and it has been shown that the luminous property depends upon the presence of sulphides.

In a recent issue of the *Journ. prakt. Chem.* (1911, LXXXIV, 305) an account is given of experiments made by Messrs. Vanino and Zumbusch to ascertain the factors upon which the luminosity depended. They found that good specimens of the stones contained from twelve to thirty-three per cent. of sulphur, and that the condition in which that element was present had a pronounced effect upon the results.

Thus stones containing only monosulphides were very deficient in luminosity, whereas in highly phosphorescent specimens there was a considerable amount of polysulphides (up to 2·5 per cent.) A small addition of starch increased the luminosity, but a larger proportion than about four per cent. had the opposite effect. The length of exposure to daylight required to induce the maximum phosphorescence varied with the composition of the stone, those of more complex character requiring a longer exposure, though they also showed a correspondingly longer period of decay.

The luminosity was not increased by confining the stone in an atmosphere of chlorine or ammonia. It was reduced to a marked extent by grinding the stone in a mortar, the colour being simultaneously altered. Exposure to sunlight also changed the colour, but it was not possible to trace any connection between the luminosity of the stone and the speed with which its colour altered.

CHEMISTRY AT THE BRITISH ASSOCIATION.—The address of the President of the section, Dr. Walker, deals with the "Theories of Solutions," which have arises upon the foundations laid by van t'Hoff. A masterly outline in

given of the present ideas upon the subject, and it is shown how certain conflicting notions may be reconciled.

Other important contributions are devoted to the "Absorption Spectra of Metallic Vapours," by Dr. Bevan, "The Compressibility of Mercury," by Dr. McLewis; and "The Use of Indicators for determining Affinity Values," by Dr. V. H. Veley. There is also an interesting paper on "The Theory of Colloids," by Professor Freundler, in which he classifies colloidal (or glue-like) solutions into two groups, viz., those in which the solid body, *e.g.*, a colloidal metal, is in a state of extremely fine suspension, termed "Suspension Colloids" or "Lyophobic Sols"; and "Emulsion Colloids" or "Lyophilic Sols" (including gelatin solutions and the like) which approximate more closely to true solutions.

In a paper upon "The Treatment of Wheaten Flour," Mr. A. Humphries describes the results of his investigation of the changes produced in flour on baking. From these it appears that a large proportion of the organic phosphorus present is converted into an inorganic form.

ALUMINIUM NITRIDE AND ITS USES. — On heating aluminium powder in the air it absorbs oxygen and nitrogen in proportions depending upon the temperature reached. Thus, at 600°C. oxygen is absorbed up to 8·8 per cent. of the weight of aluminium, but there is little or no absorption of nitrogen; while at 800°C. the amount of nitrogen absorbed is trifling. On raising the temperature to 1100°C., rapid absorption of both oxygen and nitrogen takes place, until, after about six hours, the metallic aluminium has been converted into oxides and nitride, the absorbed nitrogen being subsequently displaced by oxygen, with the final production of a hard aluminium oxide resembling alumina in properties but containing a different proportion of oxygen.

When the aluminium is heated in an atmosphere of nitrogen at 900°C., it absorbs 12·21 of that element, to form a nitride, which is decomposed into an aluminimum oxide when heated in the air at temperatures above 800°C.

In the current issue of the *Bull. Assoc. Chim. Sucr. et Dist.* (1911, XXVIII, 1010), M. Kohn-Abrest recapitulates his work on this subject, outlined above, and suggests that it may be possible to prepare aluminium nitride on a large scale from bauxite, or alumina, in the electric furnace. The products would contain from 33 to 34 per cent. of nitrogen, and in the case of bauxite would cost less to make than sodium nitrate, containing 15·5 per cent. of nitrogen. Further experiments are needed, however, to ascertain whether ammonia could be produced economically on a large scale from this source; or whether, if applied to the soil as a fertilising agent, aluminium nitride, as thus prepared, would part with its nitrogen in the form of ammonia.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

QUARTZ VEINS.—Whilst in many cases undoubtedly due to deposition from water containing silica in solution, it is now thought that some quartz veins may have an igneous origin. The "aqueous" veins generally have a "comb" or other regular structure growing out from the sides of the fissure in which they have been deposited. Quartz veins of igneous origin have a coarse pegmatoid structure, and may show graduations in mineralogical composition uniting them with typical pegmatites. The latter are admittedly igneous, and represent the final product of the slow crystallization of the more volatile residual portions of a granitic or syenitic magma. These mother-liquors, rich in magmatic water, were forced into fissures of the already-solid magma, or into the adjacent country-rock, where their extreme liquidity permitted the formation of very large and perfect crystals of the later-crystallized constituents of the magma, such as quartz and orthoclase. Quartz veins associated with granite masses may be regarded as pegmatites composed entirely of quartz, and there is no reason why they should not have the same origin as the more normal pegmatites.

It is to be remarked that the distinction between "aqueous" and "igneous" becomes very shadowy in the case of quartz veins. In discussing pegmatite Mr. Harker remarks: "The magma or solution, from which the pegmatites crystallised was igneous, in that it was the residual part of a granitic or syenitic or other igneous magma, of which the greater part had already crystallised under plutonic conditions. It was aqueous, inasmuch as it contained, perhaps very richly, magmatic water, concentrated (with other volatile constituents) in the residual magma by continued crystallization of anhydrous minerals. The pegmatites themselves represent this watery residual magma, except that the greater part of the water and other volatile substances was expelled in the final crystallization . . . . Logically, indeed, we might include under the same head simple quartz veins crystallised from solution in water (at perhaps 200°C), if both quartz and water were of direct intratelluric origin, the final residuum of an igneous rock-magma."

Some observations bearing on the origin of quartz veins in association with a granite mass have been made by W. C. Simmons, in a paper on the Foxdale Granite of the Isle of Man (*Geol. Mag.*, August, 1911). In both the larger granite mass at Foxdale, and the smaller one of Eairy, thick veins of quartz and coarse pegmatite occur. Sometimes these quartz veins, then resembling dykes, are found, outside the granite, intruded into the country rock. Associated with them and with the granite are characteristic dykes of micro-granite intruded into the slates with a N.W.—S.E. trend. The veins occur in greatest number on the south-side of the intrusion, and attain a maximum thickness of eighteen feet. In the large Foxdale Silica Quarry several veins are to be seen, which pass locally into a quartz-mica pegmatite. In one case a vein has a selvage, half-an-inch thick, consisting of a felted mass of bronzy mica; in another the selvages, again half-an-inch thick, are composed of a mixture of quartz and orthoclase. The evidence seems to support the theory that the quartz veins represent the final consolidation product of the granite magma. The selvages are believed to be due to the segregation of impurities from the molten silica solution. There is no sign of "comb" or any other structure to indicate that the veins are due to vapour or water deposition.

PETROGRAPHICAL PROVINCES.—In his Presidential Address to the Geological Section of the British Association at Portsmouth, Mr. Harker took as his subject "Some Aspects of Modern Petrology." Most of the address was concerned with what one may call "regional petrology"—the space and time distribution of igneous rocks. This is a fascinating subject, and its study is opening up some wide problems, and giving not a few hints as to that natural classification of igneous rocks which belongs to the future, but which at present is merely hoped for. Petrographical provinces are, in Mr. Harker's words, "more or less clearly defined tracts, within which the igneous rocks, belonging to a given period of igneous activity, present a certain community of petrographical characters, traceable through all their diversity, or at least obscured only in some of the more extreme members of the assemblage." It is natural to attribute such a family likeness amongst a given group of igneous rocks to a community of origin. The simplest hypothesis is that which holds all the varied types of a petrographical province to have been evolved by the progressive differentiation of an originally homogeneous parent-magma. Becker holds the view that petrographical provinces are the expression of a primaeval heterogeneity of the earth's crust, which has persisted throughout geological time. This is difficult to reconcile with the small extent and sharp definition of provinces like that of Assynt or the Bohemian Mittelgebirge. An even stronger objection is that petrographical provinces are not permanent. In the Midland Valley of Scotland, for instance, a calcic petrographical province (Old Red Sandstone) is followed by one distinctly alkaline (Carboniferous), extending over almost exactly the same area. Daly's theory of the origin of alkaline rocks as due to the assimilation of limestone by calcic magmas, is open to the same serious objections.

XUM

In the land areas of the globe, calcic magmas have a decided predominance over the alkalic. Mr. Harker makes the interesting suggestion that this is due to the association of alkaline rocks with areas of subsidence. In connection with this it is remarked that the volcanic islands in the Atlantic, from the Azores to Tristan d'Acunha (and, it might be added, many in the Pacific) have igneous rocks of alkaline facies, and conceivably belong to very extensive tracts of alkaline material now submerged under the ocean.

Mr. Harker is inclined to drop those unhappy terms "Atlantic" and "Pacific," as applied to, and synonymous with, the alkaline and calcic branches respectively of igneous rocks. Nevertheless the distribution of types upon which that nomenclature rests is regarded as none the less significant. The distribution coincides not with the Atlantic and Pacific *oceans*, but with the contrasted tectonic structures which border those oceans. Consequently it is not to be expected that the oceanic islands of the Pacific should necessarily have igneous rocks of calcic facies; on the contrary, the dominant element in their tectonics, according to Suess, being of Atlantic type, the igneous rocks should be generally alkaline, as in fact they are. The observed alkalinity of the igneous rocks of Hawaii and Tahiti, therefore, instead of constituting an objection, as urged by some American petrologists, confirms the simple generalization of distribution made by Harker, Becke and Prior.

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE weather of the week ended September 23rd, as set out in the Weekly Weather Reports issued by the Meteorological Office, was at first very fine and dry, though cool, but about the middle of the week there was a change, rain fell generally and thunderstorms occurred. The temperature was below the average in all districts, for the first time since the end of June. In the North the deficit was but slight, but in the Midlands and the South it was greater, reaching 3°·0 in England S.E. The highest maximum was 73° at Tottenham on the 18th, the next highest being 70°, reported at both Aberdeen and Guernsey, on the same day. The lowest of the minima were 24° at West Linton, 25° at Balmoral and 29° at Marlborough It was only at a few stations, however, that the temperature fell below the freezing point. In Westminster the minimum was 41°. On the grass the temperature fell to 18° at Llangammarch and to 22° at Balmoral, Hereford and Marlborough. Rainfall was in excess in all districts excepting Scotland, E. and W. The excess was greatest in the South-West, where at Falmouth and other stations the total fall was more than twice as much as usual. Sunshine was in excess in the Central and Eastern parts of the kingdom, but was in defect in the western districts. The sunniest stations were Felixstowe and Clacton with 61 hours (71%). At Westminster the aggregate was 47·2 hours (55%). At Aberdovey the total was only 13·9 hours (16%). The mean temperature of the sea water ranged from 51°·4 at Wick to 62°·9 at the Shipwash Lightship.

During the week ended September 30th the weather was changeable and unsettled, with frequent heavy rain. Temperature was below the normal in Scotland, England, N.W., and in Ireland, but above it elsewhere. The differences, however, were nowhere very large. The highest of the maxima ranged from 62° at Strathpeffer, in Scotland, E., to 72° at Geldeston, in England, E., and at Greenwich. The lowest of the minima was 28° at Balmoral, on the 25th, and only at this station did the shade temperature fall below the freezing point. On the grass, however, readings were in places much lower, down to 21° at Llangammarch, 23° at Crathes, and 24° at Balmoral. Rainfall was variable. There were some very heavy falls in Ireland and Wales on the 25th: 3·00-ins. at Roches Point, 2·23-ins. at Waterford, and 1·40-ins. at Bettws-y-coed; but in the South there were stations where the amount for the week was only 0·3-in. or even less. Bright sunshine was above the average in all districts, most so in England, S.E., where the sunniest station, Worthing, reported 57·6 hours (69%). The temperature of the sea water varied from 45° at Ballantrae to 65° at the Shipwash Lightship.

The week ended October 7th was cold and dry, with strong winds and gales in the early part. Temperature was low everywhere, especially so in England, S.E., where the mean was only 48°·0, compared with the average 52°·9. The highest reading reported was 62° at Colmonell; but at the majority of stations the maximum did not reach 60°. The lowest readings were 23° at Balmoral, 27° at Cally (Gatehouse), and 29° at Marlborough. The lowest on the grass were 17° at Llangammarch, 19° at Hampstead, and 20° at Balmoral. Rainfall was slightly above the average in England, S.E., and much above in the English Channel, where at Jersey the amount collected was just double the average. The driest district was Scotland, W., where Glasgow and Dumfries were rainless. At Tunbridge Wells and at Canterbury there were falls of over an inch on the 4th.

Sunshine was about the average, except in Scotland, W., and in England, N.W., where it was in excess, and in the English Channel where it was in defect. Douglas reported the largest aggregate 41·0 hours (51%), while Markree Castle reported the least, namely 14·0 hours (18%). The temperature of the sea water ranged from 46° at Kirkwall and Scarborough to 60° at the Shipwash and at Salcombe. A pilot balloon sent up at Manchester on the 3rd August was traced to a height of 25 kilometres, or more than 15½ English miles.

The week ended October 14th was fine generally, but with a good deal of mist and fog. Thunderstorms occurred in several places on the 13th. Temperature did not vary greatly from the average. There was an excess in England, E., S.E., and S.W., the English Channel, and Ireland, N., but a deficit elsewhere. The highest readings were 68° at Greenwich, Prestwich, Bettws-y-coed, and Cullompton; the lowest were 24° at Balmoral and 26° at Kilmarnock. Except in England, E., and the English Channel, temperatures at or below the freezing point were experienced in all districts. In the English Channel the minimum was 46°. On the grass the temperature fell to 17° at Llangammarch and to 20° at Balmoral.

Rainfall was extraordinarily low, and in seven of the twelve districts into which the country is divided for the compilation of meteorological statistics, the mean amount of rainfall was less than 0·1 inch, and in Scotland, W., the week was rainless. At many individual stations also, in other districts, the week was rainless. On the other hand, at Jersey, on the 13th, 2·42 inches of rain fell in one day. Bright sunshine was above the average except in Scotland, N., and in Ireland. The sunniest district was England, N.W., with a mean of 40 hours (53%); the sunniest station was Llandudno, with 51 hours (67%). The lowest record for the week was 0·6 hours at Baltasound, Shetlands. The temperature of the seawater ranged from 44° at Ballantrae to 59° at Salcombe.

THE SUMMER OF 1911.—In the thirteen weeks of summer ended September 2nd, the weather in England, S.E., had been unusually warm in ten weeks, unusually dry in eight weeks and unusually bright in nine weeks. The corresponding numbers for the summer of 1910 were respectively three, four and one.

INTERNATIONAL INVESTIGATION OF THE UPPER AIR.—During the period, September 11th to 16th, simultaneous ascents of unmanned balloons were made at a large number of stations in Europe and elsewhere. The co-operating stations in the British Isles were Pyrton Hill, Oxon; Ditcham Park, Petersfield; and Manchester, in England; Crinan Harbour, in Scotland; and Mungret College, Limerick, in Ireland.

Small ballooms carrying recording instruments were dispatched simultaneously, and the return of the records and the tabulation of the results is anticipated with much interest. One balloon sent up at Limerick was found at Ballater, in Scotland.

XUM

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD. ARTHUR EARLAND, F.R.M.S.
THE REV. E. W. BOWELL, M.A. RICHARD T. LEWIS, F.R.M.S.
JAMES BURTON. CHAS F. ROUSSELET, F.R.M.S.
CHARLES H. CAFFYN. D. J. SCOURFIELD, F.Z.S., F.R.M.S.
C. D. SOAR, F.L.S., F.R.M.S.

A CASE OF DIATOM-WELDING.—The photomicrograph illustrates the probable fusion of two diatoms that has taken place during mounting. The slide is an old one by Wheeler, labelled "Test Slide, Dry, *Amphipleura pellucida*, $\frac{1}{25}$ in. obj," and it is a mixed one. Mr. West, to whom this photograph and others taken at a magnification of ×1000 were submitted, is of the opinion that the smaller valve lying alongside the *A. pellucida* is a *Navicula laevissima*, and that the junction is an accidental one. I understand that in mounting test diatoms dry, it is the custom, after cleaning the cover glass, to place upon it a drop of the material with a drop of added water, and allow evaporation to take place slowly. The cover is then placed on a piece of platinum foil or ferrotype plate which is heated to redness, and it is doubtless at this stage of the process that the unnatural union has taken place.

FIGURE 1.

Obj. 2 mm. H.O.I. Apochromat N.A. 1·40 (Leitz), Oc. Compens. ×18, Achromatic Substage Condenser. Auxiliary *Lens with Iris. Screen* (D+H.) Wratten and Wainwright, "M" Series. Liliput Arc lamp. 8 Amps.

T. W. BUTCHER, M.B., C.M.

TETRASPORA (LINK).—At a recent excursion of the Quekett Club I came across *Tetraspora*, an alga perhaps not very frequently met with, and most likely often overlooked when it does occur. It was clinging to some weeds in water about a foot deep near the edge, and appeared as a pale green filmy looking body without any definite outline. There was some difficulty in collecting it—so fragile was it, that an incautious movement with the net at once caused a part to disperse in the water. The plant consists in its young condition of a colourless gelatinous sac, which later extends in various directions, becoming lobed, torn and membranous finally, it may reach a considerable size, up to several inches in length. In this are embedded in a single layer the cells which are the living units of the organism. Typically they are globose, of various sizes, according to age, and when mature divide first into two hemispheres, which soon divide again at right angles in the same plane. The four portions, at first somewhat angular, subsequently become rounded off, but not usually separating far from each other, cause the grouping into four, which is the noticeable characteristic of the plant. The mother cell-wall swells and becomes gelatinous thus increasing the extent of the colony (Figure 2 a). During some period at least of their life these cells are provided with two long "pseudocilia" (Figure 2 b), but the organism as a whole has no spontaneous motion. In reproduction zoögonidia are formed with two cilia (Figure 2 c), which swim away, but their actual development into a fresh colony has not been observed. Sometimes when a specimen has been kept in a collecting bottle for a few days, it will be found that all the cells have taken this form and settled on the side of the bottle towards the light, leaving the structureless jelly useless for examination. It is very doubtful if there is more than one well-established species, to which, however, a considerable amount of variation, owing to environment and age, must be allowed. My example, in which the cells, from eight to ten μ diameter—are arranged in groups of two or four, corresponds best with *Tetraspora lubrica* (Roth). Dr. Cooke gives four species, but is very doubtful about the last of them, and certainly the first, *T. bullosa*, from the figure—"British Freshwater Algae" Plate 6, Figure 1, appears to resemble *Monostroma* rather than *Tetraspora*; in the latter genus the cells should be at least sub-spherical except when undergoing division. Neither does he refer to the "pseudocilia," which, though they are easily overlooked and cannot be distinguished in all cases, West makes of diagnostic importance. Who also mentions the occurrence of hypnospores—*i.e.* resting spores—with thick brown cell-walls, but I have not seen them. Considerable importance is attached to the plant from an evolutionary point of view—West's "British Freshwater Algae," page 24.

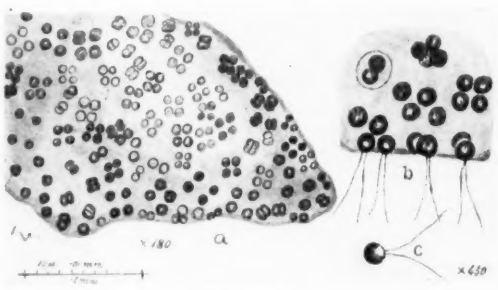

FIGURE 2.

Figure 2 a is from my own specimen, b and c are from figures in the above book.

J. BURTON.

TABANIDAE.—The exceptionally fine and hot weather of the past summer has resulted in an unusual profusion of insect life, and in no respect has this been so apparent as in the case of the Tabanidae, which, especially abroad, have been so numerous as to constitute a veritable plague. Not only have the grey Breeze flies been remarkably abundant, but the larger species of Tabanus varying in size from one-half inch to one inch in length, beset the traveller wherever he went, even on the higher slopes of the Alpine pastures, above the tree level to a height of over nine thousand feet. For the protection of the face and neck a light veil was effective, but the hands and legs were especially exposed to attack, since these flies could alight upon a glove or stocking without being noticed, and could easily pierce the skin through any tight-fitting garment. As regards the Tabanidae, the males appear to subsist on the juices or secretions of plants, but the females are extremely blood-thirsty, and lose no opportunity of attacking both animals and human beings. The mouth organs of the various species are similar, and are of considerable interest not only to the microscopist, but also to many others who, whilst suffering from the bites, at least like to know by what means they are bitten. The large fleshy proboscis—or *labium*—common to both male and female, does not greatly differ in shape or structure

from that of the well-known Blow fly, and as this organ does not take any active part in the process of bloodsucking, it need not claim our attention here. The central blade of the set of five lancets is the *labrum*, which in a specimen before us measures ·06-inch × ·01-inch but tapers toward the extremity, ending in two oval chitinous plates set obliquely on each side, each bearing about sixteen rasp-like teeth, the central portion between them being also finely toothed. The edges of the labrum are thin and sharp and furnished with delicate hairs, whilst down the centre there is a groove, the upper end of which is in communication with the alimentary canal. Immediately below this is the true tongue, or *hypopharynx*, somewhat shorter and narrower than the labrum, slightly grooved on its outer face, and tapered towards its rounded extremity. When in operation this is pressed upon the inner surface of the labrum and the grooves being then in apposition, form a tube up which the blood is drawn. On either side of these are the *mandibles*, rather longer than the labrum and about the same width, formed of two extremely thin laminae and tapering to a lancet-shaped point, the outer edges being smooth and sharp, whilst the inner edges are bordered with minute teeth the forty-thousandth of an inch in size. Outside these again are two delicate blades which are generally regarded as the *maxillae*. These are somewhat shorter than the mandibles, but are only ·004-inch wide, slightly tapering and rounded at the ends. If these are examined with a magnifying power of, say, ×150 or ×200, it will be seen that the ends are furnished with ten to twelve rows of strong teeth pointing upwards, each tooth consisting of a sharp point set in a socket of more flexible material. A short distance from the end, where the maxilla has widened to almost its full breadth, these large teeth give place to a band of teeth of a smaller size, running down either side, beginning in close rows of seven, but gradually diminishing in number until they narrow to a single tooth, leaving the central portion of each maxilla bare; the inner margin of each maxilla is smooth, but the outer edge is closely fringed with long soft hairs almost throughout its entire length. All the teeth point in the same direction, their use being, no doubt—as in the case of the reflexed teeth on the hypostome of a Tick—to enable the insect to maintain a firm hold whilst sucking up the blood. The effects of the bites of these flies vary considerably according to the state of health of the person bitten, but the after irritation is often much increased by portions of the mouth organs being broken off in the puncture by a sudden attempt to crush the creature when caught in the act. In many specimens which I have examined, the partly damaged mandibles and maxillae seem to confirm this suggestion. In some of the smaller species of Tabanidae the diameter of the suctorial tube is obviously less than that of a human blood corpuscle, and it is therefore thought by many that the saliva of the insect—probably containing some form of formic acid—is injected into the wound for the purpose of breaking down the red corpuscles to enable their contents to be more easily absorbed; but in answer to the question why are visitors so much more persecuted than natives, it is asserted that the latter become in a short time so inoculated with the poison as to be immune to the usual after-effects, as indeed is said to be the case with bee-masters, to whom, after becoming similarly inoculated, the sting of a bee merely means a momentary prick.

R T. L.

CLARE ISLAND SURVEY.—The results of this survey are being published by the Royal Irish Academy, and will form Vol. XXXI of the Proceedings. When completed there will be sixty-seven separate reports dealing with the flora, fauna, geology, archaeology, and so on, of the Island and the adjacent Mainland. We have before us Nos. 37, 51 and 52, of these reports, dealing with the Arctiscoida—James Murray; Rotifera (excluding Bdelloida)—C. F. Rousselet; Rotifera Bdelloida—James Murray. Until the commencement of the Clare Island Survey, there appears to have been no previous record of the occurrence of Water-bears in Ireland. Thirty-three species were collected in the small area under examination, and it cannot be supposed that this list is fairly representative of the whole of Ireland. When other parts of the country are examined the list will undoubtedly be considerably increased. There are eleven species which are new records for the British Isles, making the Britannic list up to sixty-one species. An interesting feature of the Irish list of water-bears is the occurrence of three species which were recently discovered in Canada and which were hitherto unknown in Europe:—*Echiniscus intermedius*, *Macrobiotus occidentalis* and *M. virgatus*. With the Canadian Water-bears is associated in Ireland a Canadian Bdelloid Rotifer—*Callidina asperula*. These facts open up some interesting questions in the geographical distribution of fresh-water organisms. Are they cosmopolitan, given the suitable conditions postulated by Mr. Rousselet in a recent paper on the Geographical Distribution of the Rotifera?

The Survey collected fifty-seven species of Bdelloids, besides a number of very distinct varieties. As there were previous records from Ireland of nine species, forty-eight are additions to the Irish fauna. The study of the list in relation to the world distribution of the species is instructive. There is not a single species which is confined to Ireland. Nevertheless, the Irish Bdelloid fauna exhibits much more peculiarity than that one fact would seem to indicate. Much importance attaches to the varieties of common species which are found, these occuring chiefly among the spiny Bdelloids, in the genera Dissotrocha, Pleuretra and Callidina. Mr. Murray's reports are illustrated with his well-known skill.

A Course of eight lectures on "The Manipulation and Theory of the Microscope" is being delivered by Mr. J. Edwin Barnard, F.R.M.S., at King's College, Strand. The lectures are addressed to advanced students of the University and to others interested in the subject. Admission free, without ticket. The syllabus shows that a very complete treatment is aimed at, and the lectures cannot fail to be of very considerable interest to students and others.

We have received Catalogue No. 2 from Messrs. H. F. Angus & Co., Wigmore Street, W., containing a list of second-hand scientific apparatus and accessories. That part of the catalogue devoted to the Microscope is divided under separate headings, such as: Stands only, stands with objectives, objectives and eyepieces, substage illuminators, and so on. All the instruments listed have been tested and adjusted where necessary. It is proposed in course of time to issue a larger list at periodical intervals.

A catalogue has also reached us from Messrs. Clarke and Page, Thavies Inn, E.C., of microscopical preparations, microscopes and accessories which they supply. Their catalogue is now issued in a much improved form to previous editions. We would draw attention to Section A of their list of mounted microscopical objects, a series of preparations mounted without pressure in cells, in which a new fluid medium is used. All these slides are particularly fine for dark ground illumination. We have before us five of these preparations, of which we would specially mention: *Corallinum rubrum*, with extended polype, Ambulacral disc and tube of *Echinus esculentus*, and the head of a Sand-wasp (*Miscus sylvestris*), showing the mouth parts. These fluid mounts are finer than any which have hitherto come under our notice.

ORNITHOLOGY.

By HUGH BOYD WATT, M.B.O.U.

NEW NAMES FOR THE GREEN WOODPECKER.—Amongst the vicissitudes of birds at the present time is the peril of losing their old and honoured scientific names and of having a fresh and unknown style conferred upon them. We suppose that it is not within the scope of the operations of the Society for the Protection of Birds to attempt to save the good name of a bird, but, if it were so, they might well intervene. A new name is now proposed by Dr. Ernst Hartert for the English form of the Green Woodpecker viz.:—*Picus viridis pluvius*, subsp. nov. With an unexpected regard for tradition the justification is added, "because of the well-known ancient superstition that its call is a sign of approaching rain." This

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proposal is made in the course of a short article "On the English and other Green Woodpeckers" in the current number of *British Birds* (V. page 125), where the authority above named distinguishes briefly five forms within Europe alone. These are:—

1. *Picus viridis viridis* L. Birds from Scandinavia, the greater part of Russia, and north-eastern Germany (east Prussia).
2. *Picus viridis pinetorum* (Brehm.) Central European birds.
3. The new name given above for English birds.
4. *Picus viridis pronus* subsp. nov., another new name; given to Italian birds.
5. *Picus viridis sharpei*. Spanish birds.

Such is the transformation proposed in the present names of *Gecinus viridis* (Linn.), and *G. sharpii*, Saunders, for the Green Woodpecker.

THE GREAT BUSTARD IN NORFOLK IN 1900-1.—The recent death of Mr. Alexander Williams, of Jerez de la Frontera, Spain, has given occasion to *The Field* (16th September, 1911) to recall his connection with the attempt to re-introduce this species (*Otis tarda*) into one of its old haunts in England. Mr. Williams collected in Spain sixteen Great Bustards, and sent them to England, in the year 1900, when they were turned out at Elveden, Suffolk, Lord Walsingham and Lord Iveagh assisting in the project to re-establish the birds as breeders. Some of the birds did manage to nest, and *The Field* publishes a unique photograph of a nest in Norfolk. The experiment was not in the end successful, the birds surviving only for a limited period, some being killed in a wanton manner and others straying and being lost.

The native British race became extinct probably in 1838, when two birds were killed near Swaffham in Norfolk. In earlier times the species occurred in the champaign parts of Britain from East Lothian to Dorset, and being the largest in size of our land-birds must have been a conspicuous figure.

A photograph of a recent Spanish nest can be seen in Col. Verner's book "My Life amongst the Wild Birds in Spain."

ANOTHER NEW BRITISH BIRD—THE SLENDER-BILLED CURLEW.—The list of occasional bird-visitors to the British Isles continues steadily to receive additions, the last reported being the Slender-billed Curlew, *Numenius tenuirostris* Vieill., obtained towards the end of September, 1910, on Romney Marsh, near Brookland, Kent. Out of a small flock occurring there, three were shot, one of which is figured in *British Birds* for October, 1911, (V., page 124), with a brief account of the species by Mr. M. J. Nicoll. It winters in the countries bordering the Mediterranean Sea and breeds in Western Siberia. It has been met with rarely in Heligoland, Germany, Holland, Belgium and northern France, but not hitherto in Britain.

THE FULMAR'S BREEDING RANGE.—The Fulmar Petrel (*Fulmarus glacialis*) is one of our native birds which, happily, is spreading as a nesting species within the United Kingdom. The latest new breeding localities reported are in Ireland, on the northern coast of Mayo and on a cliff in Ulster. (*The Irish Naturalist, 1911*, pages 148, 149-152, 152-154). The original breeding station in the British Isles is St. Kilda, and this was for long the only one place so known. Since 1878, birds have been nesting in Foula, Shetland, and they are now known in several localities in Shetland and also in the Orkneys, where they first occurred as breeders in 1891. The first nests on the Scottish mainland were probably in 1897, and some three different places there are reported to be now frequented. Scottish islands on which the species has within recent years commenced to nest are Handa, Barra, the Flannan Isles, Fair Isle, and North Rona. It seems justifiable to assume that this expansion means an actual increase in the total numbers of the bird.

TWEED BIRDS.—The latest volume published in the fine series of the "Vertebrate Fauna of Scotland" is from the pen of Mr. A. H. Evans, and entitled "A Fauna of Tweed" (Edinburgh, 1911). It surveys the romantic region of the Eastern Borders, including part of Northern Northumberland, and the Farne Islands. The varied natural features of this extensive district—islands, sea-shore, coast-lands, lowlands, valleys, glens, moors and hills up to the altitude of The Cheviot (2676 feet)—secure an *ornis* fairly representative of our native birds, although perhaps not so numerous in species, as might be anticipated. Some two hundred and sixty-five different kinds (including eleven whose occurrence in the area requires verification) are dealt with in the Aves section of the work (pages 52–246). The accounts given of the Grasshopper-Warbler, Pied Flycatcher, Great Spotted Woodpecker, Barn and Short-Eared Owls, Shoveler, Stock-Dove and Pallas's Sand-Grouse may be singled out as particularly full of information and interest.

BIRD-OF-PARADISE SINGING.—Mr. Walter Goodfellow made the observation, when in Dutch New Guinea last year with the British Ornithologists' Union Expedition, that the King Bird-of-Paradise possesses a song which is sufficiently melodious to command attention even were it to be heard along with that of other birds recognized or classed as song-birds. The songs of the natives of the country on the Mimika River have a remarkable resemblance to this bird's notes, and invariably end with the loud calls which it gives. These may sometimes be heard from the birds kept in the Zoological Gardens, London.

TERRESTRIAL MAGNETISM AND CARRIER-PIGEONS.—In finding their way birds of passage are said to be influenced by the magnetic meridian, and M. A. Thauziès, a French specialist in carrier-pigeons, has given some interesting information respecting their perception of terrestrial-magnetic currents. At last year's Geneva International Congress of Psychologists he gave an account of his twenty-three years experience and observation, which have brought him to the conclusion that the sense of direction in these birds is influenced by such currents.

As instances, on 22nd July, 1906, and 18th August, 1907, the results of numerous flights by carrier-pigeons were very bad. Pigeon-fanciers, meteorologists and astronomers who were consulted, could give no explanation. Marchaud, a specialist in electro-magneto research, found a solution by ascertaining that on these two days an exceptional electric tension of the atmosphere manifested itself in magnetic storms. Such observations accord with the fact discovered by pigeon-fanciers, that, with the great increase of wireless telegraphy, much less reliance can be placed on carrier-pigeons. (See "Sense of Direction in Animals and the Magnetic Meridian," by Dr. K. Endriss, translated by L. R. S. Tomalin, from Dr. Jaeger's "Monatsblatt").

PHOTOGRAPHY.

LOW POWER PHOTOMICROGRAPHY FOR NATURALISTS.—The ordinary photographer for the most part is concerned with images which are very considerably less than the objects, though at times he may do copying work up to "same size," or life size. The photomicrographist, in turn, is chiefly occupied with such magnifications as 50, 100, 500, or 1,000, or even 10,000 diameters in rare cases. But between these two useful fields of work is a large region where magnifications of 2, 3, 4, and so on, up to, say, 10 diameters is of peculiar interest to the naturalist. In a word, what the naturalist in the field can see with an ordinary pocket magnifier or Coddington he would like to be able to record permanently by means of photography with the minimum expenditure of labour and outlay for special apparatus.

Having made a considerable number of experiments in this low magnification region I propose to set forth in detail some of those aids which are easily home-made and have proved useful and practical. It is here assumed that the worker possesses an ordinary field, or bellows camera, lens, and tripod, and is familiar with the usual procedure of negative-making.

Figure 1 shows a quite simple and effective expedient for

holding a camera vertically over such a small object as a flower. This is laid on a sheet of gray non-shiny, but not very rough, paper, and supported at a convenient height above the floor by a box, pile of books, and so on. The camera is held in the position shown by tying the tripod legs to the top rails of two chairs. The sheet of white cardboard on edge between the box and chair is used as a reflector to prevent the object casting too dark and detail-less shadows. This method also serves conveniently for copying maps, plans, diagrams, and so on, in books. The photographic reader will scarcely need to be told that to copy "same size" the lens will have to be at double its focal length from the ground glass, and also this same distance from the object.

To find the lens-to-image distance for any magnification, *e.g.*, 4 times, we add 1 to 4 getting 5 and multiply this by the focal length. Thus with a 6-inch lens and 3 diameters magnification the *lens to image* distance is 3 plus 1 times 6, or 24 inches. While the *lens to object* distance is one third of 24 or 8 inches. It will thus be seen that in this field of work our limit of magnification depends on the relationship of focal length of lens to camera bellows length. Thus to find the greatest magnification with a 12-inch bellows and 4-inch

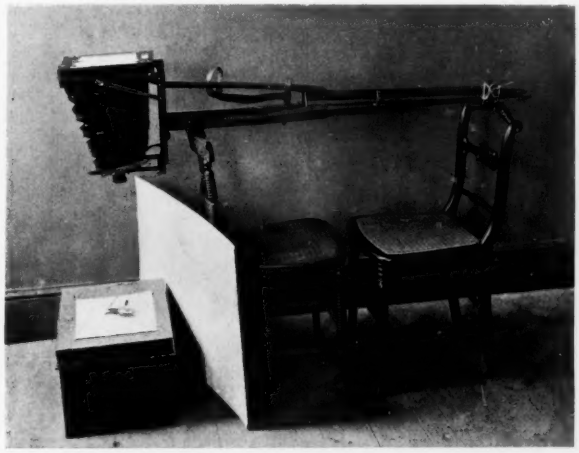

FIGURE 1.

lens we divide 12 by 4 and get 3. Then subtracting 1 we get 2, or the maximum magnification with a 4-inch lens and 12-inch camera bellows is 2 times *i.e.* double life size. Finally, requiring to know what lens will give us 10 diameters magnification with a 24-inch camera bellows we add 1 to 10 getting 11, and then divide 24 by 11 getting $2\frac{2}{11}$, as the maximum focal length, so that to be on the working side we should limit our focal length to 2 inches. The above scraps of simple arithmetic must be kept in mind whenever we are fitting up home-made contrivances of the sort to be herein below mentioned.

I now turn to an easily-made apparatus (Figure 2) that I have had in use for many years with complete satisfaction. It is especially well adapted for small objects, *e.g.*, shells, fossils, seeds, and so on, which can be stuck to a card, or small enough to rest on a quite narrow (half-inch) shelf.

Figure 2.—A, the top of an ordinary tripod stand. The camera screen is attached to the under-side of the triangular top by means of a cheap steel watch chain with swivel end, which engages with a ring passing through the pierced head of the camera screw. This prevents the camera screw from being lost. BB a straight grain piece of (teak) wood, say three feet long by four inches wide by half-an-inch thick, which acts as an extension and base board. The camera screw passes through its usual hole in the tripod top, then through a hole in BB, and finally enters the "bush" let into the base of the camera. These three parts now become as one solid piece on tightening the screw. CE is a loose piece (see Figures 3 and 4) which slides along BB.

D is a loose piece which slips over the top of the upright par E, and it forms a shelf (Figure 3). These two moving pieces are made out of the wood of an old cigar box, and cigar box nails.

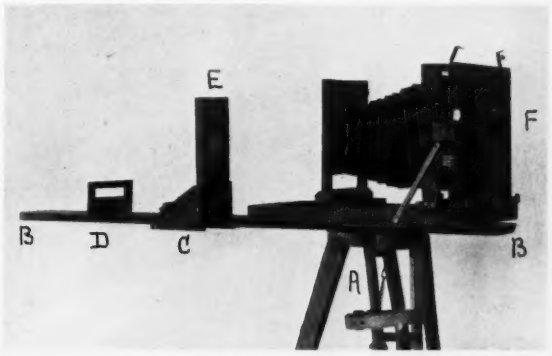

FIGURE 2.

At F we see the plate end of the camera, but the reversing back and focussing screen have been removed, so that we may see a contrivance which enables us to use the right and left-hand halves of a quarter-plate for two different pictures. This effects economy of material (cost), time, and storage space when we are—as is often the case—concerned with images which occupy only a small fraction of a quarter-plate. (The two figures 3 and 4 were thus taken side by side on one quarter-plate). The contrivance consists of a piece of cardboard, blackened on both sides. It is of such a size that one can bend and spring it into the last groove of the camera bellows just inside the camera body. When it is pushed as far as it will go to one side, it is just big enough to obscure half the focussing screen, so that when pushed to the other side it similarly obscures the other half. The procedure is: (1) push the card to right; (2) focus on the left half of screen; (3) insert the plate holder, expose, close the slide and withdraw it from the camera; (4) push the card to the opposite side; (5) focus on the other half of the screen for the second picture; (6) insert the plate holder, expose, close and withdraw it, and so on. We have now two image exposures on the plate side by side.

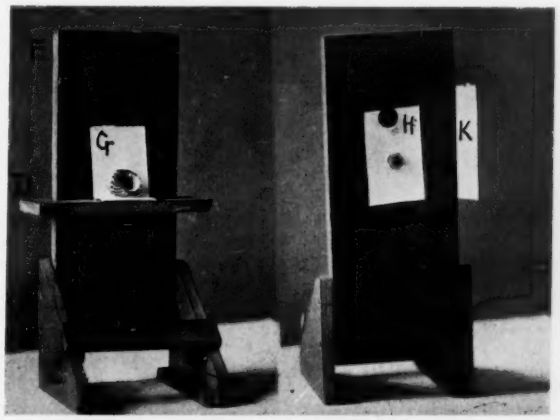

FIGURE 3.

FIGURE 4.

Figures 3 and 4 show the two sides (front and back) of the sliding object holder. Figure 3 shows the shelf, D, slipped over the upright part, E, and held in place by a drawing pin below D. A small shell rests on a piece of paper to serve as a background, G. Figure 4 shows a small shell stuck to a piece of card which is held in place by a drawing pin, H. At K we

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have a small piece of white card pinned to the edge of the upright wood. This serves as a reflector and prevents the shadows being too dark.

The special points about this easily made piece of apparatus are that it calls for no alteration of the camera in use, though one may have to buy an extra long camera screw; and it enables one to move the object and camera *together*, so as to get any kind or direction of lighting. If a passing vehicle sets up vibration in the room where work is going on the whole apparatus is equally affected, so that the definition does not (apparently) suffer.

Figure 5 shows an ordinary result obtained by this contrivance. Figure 6 shows us a life-size view of two cowrie shells stuck on a card (*vide* Figure 4). Figure 5 shows us a magnified image, enlarged about 7 diameters, of one of these shells. It may be of interest to say at once that the negative of Figure 5 was taken not with a lens, but with a "pinhole" (*i.e.*, made with a needle) in a thin piece of sheet copper. This sheet metal, obtainable from any metal dealer, is about the thickness of a thin visiting card. A circular piece is cut as an easy fit to the inside of the lens tube. The glass parts of the lens are unscrewed and laid aside. This disc of metal is pushed up inside the tube so as to rest against the stop or diaphragm, and the centre pierced with a No. 1 needle. The hole which passes the fattest part of this needle is about $\frac{1}{30}$-inch in diameter. In this case the hole was about 14 inches from the plate and about 2 inches from the object. Although a pinhole does not give the definition sharpness of a lens at its best for any one plane, yet the pinhole give us a certain *evenness* of soft definition which for some objects is particularly effective. In photographic parlance, the pinhole gives us great depth but poor definition. As a matter of fact this $\frac{1}{30}$-inch hole is too large for best pinhole definition at 14 inches. At this distance we should get a sharper effect with about $\frac{1}{80}$-inch hole, *i.e.*, a No. 5 needle. The reader, will of course, understand that a good modern 2-inch lens, duly stopped down to say F.44 would have given a sharper picture over a certain depth of subject, but would have brought into prominence the differences of definition of the various planes in an unpleasant way. This more or less hemispherical subject was chosen as typifying a markedly difficult case as regards depth of subject, and thus showing that at times (*e.g.* fossils showing *form* rather than *detail*) the homely pinhole gives a more effective rendering than the costly lens. I emphasise this point because the use of a pinhole for this class of work is practically unknown to most workers.

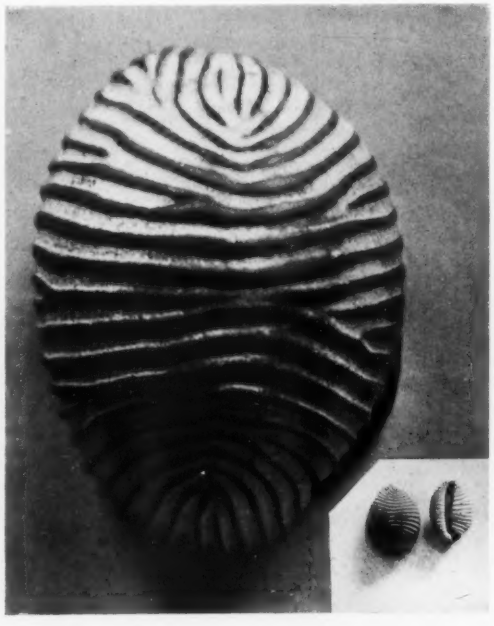


FIGURE 5.

FIGURE 6.

The following table shows one the best size of hole for sharpest definition at various plate distances:—

Plate Distance	6	8	10	15	20	30 inches
Diameter of Hole ...	$\frac{1}{50}$	$\frac{1}{45}$	$\frac{1}{40}$	$\frac{1}{30}$	$\frac{1}{25}$	$\frac{1}{20}$,,
Number of Needle...	9	8	7	5	2	1

The sizes of needles of various numbers vary slightly among different makers; but the above sizes, which are those of Milward's Sharps, may be taken as generally representative.

Of course, exposures with a pinhole are much longer than with ordinary lens apertures; but, beyond the matter of patience, this is of no account with non-moving objects. Although it is wrong in theory, yet it works out all right in practice to base exposure on the F. value of the pinhole. Thus a hole $\frac{1}{40}^{th}$ inch diameter, at 10 inches from the plate, may be reckoned as F.400.

To compare this with a lens working at F.32, for instance: the squares of 32 and 400, viz., 1,024 and 160,000 are roughly 1 to 160, so that ten seconds with F.32 would be equivalent to (about) twenty-seven minutes. But as a little extra exposure is better than under exposure one would in such a case give thirty minutes. There is the further consideration with pinhole exposures, viz., that the occasional periods of vibration due to passing vehicles are usually negligibly small in comparison to the total time of exposure.

F. C. LAMBERT,
M.A., F.R.P.S.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

OPHTHALMIA ELECTRICA.—L. Bell has published recently in "The Proceedings of the American Academy" an investigation on glasses used as a protection against the injurious effect of light on the eye. Bacteria are rapidly killed by radiations of a smaller wave-length than 270 $\mu\mu$ in the ultra-violet, while the ultraviolet radiations are absorbed by air considerably if less than 230 $\mu\mu$, and by glass if less than 310 $\mu\mu$. The symbol is an abbreviation for a micro-millimetre or one-millionth of a millimetre; thus the wave-lengths of the ultraviolet region range from about three hundred and sixty millionths to about one hundred millionths of a millimetre in length, shorter than which they are so readily absorbed that they have not yet been measured. All ordinary glasses absorb the ultraviolet rays which have cell destroying power or bactericidal effects. Common amber-coloured glass cuts off all the ultraviolet region. In contra-distinction to this a yellow filter of gelatine soaked in dimethylaniline permits some of the longer ultraviolet waves to pass, but cuts off a large portion of the visible region, and can, in conjunction with other screens, cutting off the yellow (*e.g.*, cobalt glass), be used to filter through the ultraviolet rays.

Arc lamp workers, and those that work electric furnaces, which, by the way, are in use now for preparing high grade steel from rich Norwegian ores, are rarely affected by true "ophthalmia electrica" chargeable to the ultraviolet rays, but are very often affected by the intense luminous radiation. The vitreous humour and crystalline lens of the eye is capable of absorbing most of the ultraviolet radiation, but there appears to be some particular wave-length which gets through rather easier, and is apt to cause trouble. The remedy is to wear glasses when dealing with arc lamps or quartz mercury vapour lamps; while, to prevent the injurious effect of the luminous radiations, glasses should be slightly tinted.

It is interesting to compare the transparency of quartz, uviol glass and an ordinary photographic lens to ultraviolet waves. The photographic lens does not let through waves shorter than 365 $\mu\mu$, while uviol glass, a glass made in the Schott and Genossen works at Jena, allows through light of 265 $\mu\mu$ and quartz even shorter waves.

SELENIUM.—This element exists in several modifications called in the language of the chemist, allotropic forms. There is a red amorphous form, a grey crystalline form and a darker, almost black, form. All these three forms, though

differing in their physical properties, are one and the same chemical substance though the atoms may, perhaps, be compounded into different sized molecules in the various allotropic forms. They differ in their electrical conductivity among other physical properties. Selenium cells have been constructed which are sensitive to light; when exposed to light the electrical conductivity decreases considerably. The selenium in this sensitive state contains at least two of the allotropic forms, and the light changes one form into the other, the effect being reversible when the light stimulus ceases. Metallic selenides, in small quantity, seem to improve the sensitiveness of the selenium. Selenium cells are constructed by compounding films of selenium with mica sheets, or between wires, or the selenium may be condensed on to a cold surface, in which case it possesses very little inertia and attains its maximum or minimum conductivity very quickly and without showing inertia as in the case of ordinary fused selenium. Selenium cells have been used as receivers for wireless telephony. Rühmer succeeded in telephoning along a fluctuating light beam over ten miles. A vibrating membrane controls the beam of light and causes it to fluctuate in intensity according to the intensity of the sound vibrations. The selenium at the other station receives the beam of light and alters its conductivity according to the intensity of the light falling on it. A telephone connected to the selenium cell is thus affected according to the fluctuation and intensity of the current and of the light beam and therefore of the voice transmitted.

Röntgen rays affect selenium just as light does—yellow light is most active. Some years back I made a few experiments on this point hoping to get a very marked effect with Röntgen rays owing to their penetration throughout the mass of the selenium. The change in conductivity is considerable, but no comparisons were made of the energy in the Röntgen beam with that in a light beam producing equal change in conductivity, and so the results were only of small value. The idea was to try other allotropic substances—such as tin, to see if they were influenced throughout their mass, by X rays, whether they would possess similar properties to selenium.

Another substance of considerable interest as regards electrical conductivity is silver sulphide which, as Faraday suggested, possesses a negative coëfficient of resistance, *i.e.*, its resistance decreases as the temperature rises. When first heated the resistance decreases rapidly; but as it cools, though it does not return to its original high resistance, yet the resistance is greater than when hot; after considerable heating and cooling the resistance does not alter much on further subjection to change of temperature. The author, H. V. Hayes, of recent work on this peculiar substance, seems to infer that the temperature coëfficient of resistance of silver sulphide is not really negative, but that the apparent effect is due to imperfect contact at the junction of the leading-in wires and the silver sulphide.

RADIATIONS FROM LATEX OF *EUPHORBIA PEPLUS*.—Chapman and Petrie find that the latex of this Australian spurge possesses the property of affecting photographic plates through paper, or even through aluminium foil. The latex seems to give off a penetrating radiation which must be comparable in intensity with the radiation emitted by uranium or thorium. It has been found that many substances affect the photographic plate, the effect in some cases being due, perhaps, to hydrogen peroxide; in other cases, and more commonly, to the production of ions in the neighbourhood of the substance, either by radiations from the substance or by a chemical change induced by moisture or other causes on the substance. It has been found to be quite difficult to obtain a paint to inscribe the numbers on the black paper in which films are rolled owing to this phenomenon. This particular latex, however, seems to possess the property to a remarkable extent.

RADIATIONS.—When describing in one of our recent issues the instrument by means of which Professor Wood was able to isolate ultra-violet waves free from visible rays, I mentioned that it was also a convenient method of isolating long heat waves. Professor Rubens has been able by means of such a quartz lens apparatus to isolate waves one-third of a millimetre in length from the radiations emitted by an intense mercury vapour lamp. Now visible rays at the extreme red end of the spectrum are less than $\frac{1}{1000}$ of a millimetre in wave-length, while very short electro-magnetic waves of only a few millimetres in length have been produced by Fessenden and others. The complete range of ether vibrations has thus been nearly bridged experimentally. It appears quartz is extremely transparent to these long heat radiations. Diamond, selenium, amber, paraffin and vulcanite are fairly transparent, much more so than to the one-tenth of a millimetre waves, which can be isolated from the Auer-mantle radiations. Such invisible radiations are detected by means of a bolometer or radiomicrometer. The first is a small black very thin strip of platinum or silvered platinum, which alters its resistance when radiations are absorbed by it; two such strips of equal resistance are placed close to each other and an electric current is made to pass down each strip—their resistance being the same, the current in each branch will be the same; if the resistance of one be altered, then the current in one strip is greater than in the other, and so an effect is produced on a galvanometer connecting the two branches of the circuit containing the two strips. The radiomicrometer is an exceedingly delicate thermopile. When a junction of cadmium-antimony and bismuth-antimony is heated an electromotive force is set up which tends to drive a current down a wire connected to the two. In the radiomicrometer, a silver strip is situated between such a junction and the two ends of a silver wire are connected to the two alloys and the wire is looped so as to hang vertically from a quartz fibre inside a copper tube between the poles of a permanent magnet. When the radiations, say of a candle placed 10 metres away, fall on the blackened strip of silver, a current passes down the loop, and the magnetic action is such as to turn the coil, which motion is registered by a spot of light moving over a scale.

Langley, by means of the bolometer, mapped the infra-red spectrum of the sun to nearly a wave-length of $\frac{1}{20}$ millimetre, but below this the radiations are absorbed by the atmosphere. He was also able to estimate from an examination of the moon's radiation that the temperature on its surface was less than 0°C. Sir William Abney succeeded in photographing, the shorter infra-red rays. Bathed plates, to photograph objects in infra-red light, can now be bought commercially, but they do not record a wave-length of more than $\frac{1}{1000}$ millimetre. Such plates are bathed in dyes (Alizarin blue, Nigrosin, diazo black, cyanin, and so on) which absorb red rays. The energy of these rays go to change the constitution of the sensitive emulsion, and a photographic record is the result. Now Abney conceived the idea of making silver bromide absorb red light instead of blue light as is usually the case: he succeeded in obtaining an emulsion of silver bromide which transmitted blue light and absorbed red, and the plates he thus made he employed to photograph waves of even $\frac{1}{500}$ millimetre. P. V. Bevan has recently investigated the absorption and dispersion of light by alkalimetals—that is, by potassium, rubidium, lithium, caesium and sodium. The measurements are somewhat difficult to carry out with such metals owing to the fact that they attack most materials with which they come in contact. Lithium vapour even attacks steel tubes. It appears from this work that different specialised atoms are absorbing different spectral lines, so that a certain percentage of atoms in the vapour may be employed in absorbing one particular wave-length of the incident light, while another is absorbing another wave-length. This idea is distinct from the idea that within each atom the electronic arrangement is such that certain groups of electrons are responsible for the absorption of the various incident radiations. An electric current passed through such vapours of metals under diminished pressure gives rise to a variety of spectra akin to flame, arc and spark spectra according to the electric conditions. The luminosity of the vapour of sodium will mask the spectrum of helium when present in such tubes. The masking effect of the spectrum of one substance on that of another is a matter of great interest.

The salts of potassium are radio-active; they emit a penetrating radiation, which appear to be of corpuscular nature like part of the radiation (β rays) from radium.

XUM

Rubidium likewise emits a less penetrating radiation, but caecium, which is so akin to rubidium chemically, does not appear to do so, unless such particles are moving too slowly to be detected.

Radio-activity has now developed to such an extent that the knowledge of its processes leads it now to be applied to the elucidation of many problems of a less specialised character. Professor Rutherford has recently thrown much light on the structure of the atom, by a theoretical investigation of the action of the α and β particles penetrating an atom, while his theoretical deductions are well backed up by the experiments of Geiger and Marsden and Crowther. Mr. Marsden is likely to give to readers of "KNOWLEDGE" an account of this work, and I will therefore only indicate the nature of Rutherford's theory. He starts by assuming the atom to consist of a central nucleus with a charge equal to the number of electrons multiplied by the charge on each ($4{\cdot}65\times10^{-10}$ electrostatic units), while there is an outer shell carrying an equal and opposite charge. He investigates what would happen if an α particle (a positively charged atom of helium) emitted, say from Radium C, were to penetrate such an atom, and what the chance would be for a large deflection of such a particle. He finds that when the α particle penetrates very close to the central nucleus, its deflection will be very large and it may be deflected 150° or so, back towards the direction in which it came. It appears from experiments on the percentage of particles deflected at various angles, or measured by the number of scintillations occurring in unit time on a zinc sulphide screen placed to receive them, that the number of large deflections is greater than would be given by an atom of such a character that the large deflections would be made up of a number of smaller deflections. This effect no doubt does occur to some extent, and especially with the lighter β particles, which, although moving more rapidly, do not possess so great energy as the α particles. Professor Rutherford's theory of the central condensed charge in the atom explains well the experiments on the diffuse reflexions of α particles, on the variation in the percentage deflection at different angles with the atomic weight of the reflecting atoms, on the average scattering of the rays produced in penetrating thin plates of various metals, and on the scattering of β rays of different velocities by atoms of different weight. The outer charge of the atom is probably that of a number of electrons moving as satellites to the central charge. This idea is similar to the theoretical idea of the atom worked out by Nagaoka, which was something of the nature of a minute planet Saturn. It is likely that this scintillation work will give much information on the structure of the atom. The problem is akin to that which would present itself to a philosopher living outside the solar system, and who wished to investigate the structure of it by the orbit and perturbations of a comet passing through the system. But in our case the comet or α particle is more under control.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

THE LIVING EARTH.—It has been shown by Drs. Russell and Hutchinson, of the Rothamsted laboratory, that soils heated or treated with certain volatile antiseptics, and brought again under conditions favourable to plant growth, show a great increase in fertility. The soil bacteria are first reduced in numbers and then they increase enormously. To this increase is due an increase in the production of ammonia in the soil, and to this the greater fertility. But why should the decrease of bacteria be followed by their great increase?

To explain this it has been suggested by the authors named that the treatment with volatile antiseptics kills off the protozoa of the soil, some of which feed on bacteria, and thus limit their increase. The protozoa are more susceptible than the bacteria to the sterilising agents. When they are killed off the bacteria multiply without this check. But our knowledge of the protozoa of the soil is somewhat scanty and vague.

We welcome therefore a recent investigation by Mr. T. Goodey, in which he names about thirty protozoa found in cultures of soil. Eighteen of these are ciliated infusorians, and in regard to these Mr. Goodey comes to the interesting and important conclusion that they exist in the soil in an encysted, not in an active state. "In consequence, they cannot function as the factor limiting bacterial activity in the soil."

HOW LONG DO WHITE MICE CARRY THEIR YOUNG?—One would have thought that a simple question of this sort admitted of ready answer. The usual statement is that the period of gestation is twenty-one days, the same as the period of a chick's development. But J. Frank Daniel reports that there is great variability in the duration of the period—in different mice and in the same mouse. For non-suckling mothers a definite gestation period of practically twenty days may be stated; and this holds true irrespective of the size of the litter. But for suckling mothers there is great variability, from a minimum of twenty-two days to a maximum of thirty days. And it seems that the period of gestation in suckling mothers varies directly with the number of young suckled. The "how" of this relation, if it is a well-established relation, remains uncertain.

BITE OF HELODERMA.—The virulence of the venom of the Gila Monster, the poisonous lizard of Mexico and Arizona, has been often proved in the case of small animals, but we have little precise knowledge of the effect of the poison on man. This gap has been filled by the careful observations of Mlle. Marie Phisalix, who was accidentally bitten while examining the lizard's mouth. She describes the intense pain, the swelling, the profuse perspiration, the giddiness, and other disagreeable results of the bite. Even after a week the fatigue, the giddiness, and the local pain had not disappeared, but no serious consequences ensued.

SLOWING DEVELOPMENT OF HERRINGS' EGGS.—One of the methods suggested in order to secure the introduction of the herring into New Zealand waters is that of lengthening out the period of embryonic development, so that transportation of the eggs may perhaps be effected before hatching occurs. Dr. H. Charles Williamson was able some time ago to lengthen out the period of embryonic development to fifty days. He did this by lowering the temperature, which probably makes the formation of nuclein-compounds slower, and therefore retards cell-division. His further endeavours to extend the period have not been successful. Lowering the temperature still further slows the development so much that it is very apt to stop altogether.

THE HIBERNATING SNAIL.—It is interesting to connect the internal and external periodicities, and there is a great deal of interesting work to be done in comparing the details of organic structure at different times of year. Taking the common *Helix pomatia*, Spiro has recently shown that the granules and drops of fat which are abundant in the summer in the cylindrical cells lining the alimentary canal are all gone in winter; that the nuclei of these cells become poorer in chromatin; that the cilia which all the cylindrical cells have are lost. There is another kind of cell in the lining membrane, vase-like in shape, which secretes mucus in summer during digestion, but, of course, ceases to do so when hibernation sets in. We thus get the impression of the depth of the organism's reaction to the seasons. It is also very interesting to find that the whole lining of the alimentary canal is renewed in spring before the nutritive period of the year re-commences.

HABITS OF SCUTIGERA.—J. Künckel d'Herculais has been studying the well-known long-legged centipede called *Scutigera coleoptrata* which is common in houses. It is famous for the disproportionately long limbs, fifteen pairs in all, for its compound eyes, and for many other peculiarities, but what Künckel d'Herculais calls attention to is its activity as a fly-catcher. During the day it lies quiet in crevices about the doors and windows and flooring. At night it goes on the hunt and kills large numbers of flies, *e.g.*, *Fannia scalaris*. It throws itself upon the fly, enwraps it in its

posterior limbs, and injects the instantaneously paralysing venom from the forceps. It sometimes kills three or four without stopping to eat. The dead bodies are masticated, but only the soft parts are ingested.

ASSOCIATIONS.—Professor Charles Chilton, of Canterbury College, New Zealand, has recently described some interesting examples of what he calls "commensalism,"—a term which should, we think, be restricted to cases of mutually beneficial external partnership. One of these cases is that of a crab (*Paramithrax longipes*), which seems to be almost invariably accompanied by specimens of *Balanus decorus* growing on its carapace, the cirripedes being in some cases so large and numerous that they exceed in size the body of the crab itself. Here we have to deal with an "epizoic association," probably quite unimportant in its initial stages, but gradually, as the cirripedes grew, becoming inimical to the welfare of the bearer.

The second case is that of a hermit-crab (*Enpagurus stewarti*), which has a straight abdomen, and inhabits tubes formed by a *Millepora*, or, in other cases, "a massive calcareous Polyzoön, which is very much larger than the crab, so much so that it seems doubtful if the crab can drag its large, solid dwelling-place about with it." Professor Benham has suggested that the cylindrical cavity inhabited by the crab may be due to the decay of a branch of seaweed around which the Millepore or the Polyzoön grew.

Some of the associations that have been reported from time to time are very remarkable, and Professor Chilton refers to Dr. Alcock's description of the intimate commensalism between an Indian Ocean hermit-crab, (*Paguristes typica*), and a sea-anemone of the genus *Mamillifera*. The sea-anemone settles on the hinder part of the young hermit-crab's tail, and the two animals grow up together in such a way that the spreading anemones "form a blanket which the hermit-crab can either draw completely forward over its head or throw half-back as it pleases."

BEE DISEASE.—We notice that Dr. H. B. Fantham and Dr. Annie Porter have found bees and combs, from Cambridgeshire and Hertfordshire, infected with the Microsporidian (*Nosema apis*) which was found by Zander in Bavarian bees. This parasitic Protozoön belongs to the same genus as the organism which causes pébrine or silkworm disease, and the authors think that it has been responsible for a good deal of the "bee disease" of recent years. It causes a sort of dry dysentery. Infection occurs by means of spores, as was experimentally proved. Unluckily, the only certain destructive agent is fire. It must be noted that according to Dr. Malden there is also a bacillary infection in bees, the parasite being called *Bacillus pestiformis apis*.

A TELL-TALE CARTILAGE.—In the inner upper corner of our eye there is a minute half-moon-shaped fold, the *Plica semilunaris*, an item in that museum of relics of past history which we carry about with us in our body. For it corresponds to the third eyelid (in whole or in part) which is well-developed in most mammals and helps to clean the eye. It is vestigial not only in Man, but in Monkeys and in Cetaceans. Its practical absence in the Cetaceans is compensated for by the continuous washing of the eye with water, and in the other cases to some extent by the frequent movements of the upper eyelid. It seems to be a very old structure this third eyelid, for it is the "nictitating membrane" that is flicked across the eye of birds, and it is also represented in most Reptiles. What prompted these remarks, however, was not the *Plica semilunaris* itself, but a minute cartilage which it sometimes includes even in Man. This is a great rarity in white races, occurring in less than one per cent. Giacomini found it in four cases out of five hundred and forty-eight whites. But he found it twelve times in sixteen coloured people, and Adachi found it five times in twenty-five Japanese. Dr. Paul Bartels has recently examined twenty-five South African natives (eight Hereros and seventeen Hottentots) and has found the cartilage in twelve. Now as the cartilage is found in all Apes and Monkeys it seems fair to say that, so far as the cartilage of the third eyelid vestige goes, some races are more theromorphic than others,—more conservative of their historical relics.

YEASTS OF INSECTS.—We are continually impressed with the inter-relatedness of organisms in the web of life, and an interesting fresh case has been recently reported by Dr. Karel Sulc. He has been studying accumulations of reserve material which occur in Aphides, Scale-insects, Coccids, and related insects, and finds circumstantial evidence of a widespread symbiosis between the insects and various specific yeasts of the Saccharomyces type, which seem to work out changes in the stores within the body.

SENSE OF DIRECTION IN THE BLIND.—It is well known that most blind people become aware when they are approaching an object or even when an object is very quietly brought near them. There has been a great deal of speculation and not a little experimenting concerning this sense, which has received many names—sense of obtacles, facial perception, sense of direction, feeling at a distance, and so on. The accounts that the blind themselves give of their perception are very contradictory. Some investigators have regarded the sense as a fine facial touch-sense, others as due to heat-waves, others as sensitiveness to changes of pressure in the air, others as auditory. Recent experiments of an ingenious kind made at the Institution for the Blind in Paris, have led M. Truschel to the conclusion that the perception is of an auditory nature and due to the fact that the object reflects and alters surrounding sounds. To the objection that a deaf-mute has been reported as showing the power, he answers that those deaf to music and speech are often sensitive to very feeble noises.

LOADING BRICKS BY GRAVITY.

By FRANK C. PERKINS.

By using ball-bearing rollers the force of gravity may be utilized for conveying bricks a long distance for loading on cars as shown in the accompanying illustration (Figure 1). No hand labour whatever is required, and no power is utilized with this carrier system, which takes advantage of gravity to do the work. The bricks are simply placed on the carrier within the kiln and they are started on their way to the car, where they are loaded by another operator and placed in position for shipment. The friction is so small on the ball bearings of the rollers that only a very slight incline is necessary on the conveyor system to automatically carry the bricks long distances, and the various sections of the conveyor may be shifted as desired, the material to be loaded taking single and double curves when necessary without difficulty.

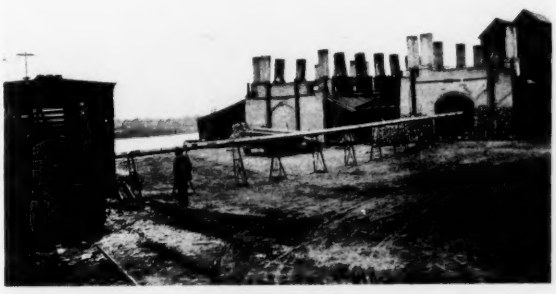


FIGURE 1.

SOLAR DISTURBANCES DURING SEPTEMBER, 1911.

By FRANK C. DENNETT.

DURING September the Sun's disc appeared to be without disturbance, bright or dark, on the 13th, 15th to 20th, 25th and 30th. All disturbances after the 10th were faculic only. The longitude of the central meridian on September 1st was 325° 45′.

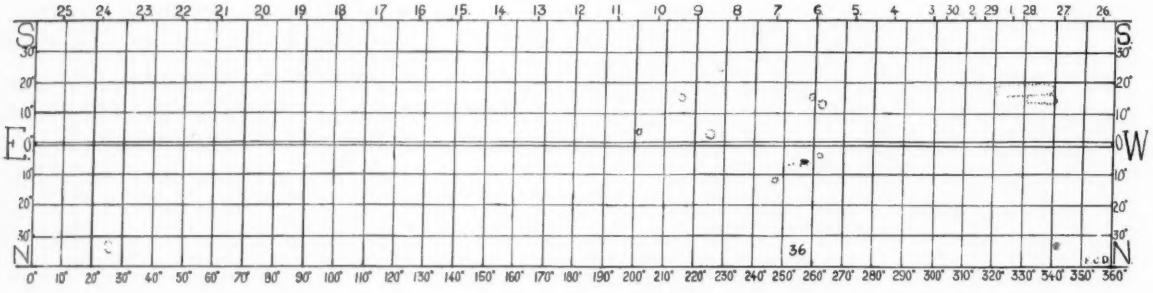
No. 36.—The only spot disturbance during the month. It was first seen as a moderate spot, about eleven thousand miles across, with a bright bridge over its umbra, on September the 1st, and a trail of spotlets extending towards the North-East. The bridge over the umbra was an interesting object until the 6th, and on the 5th it showed complicated detail, and was double in a part of its length. On this date the spot seems to have attained its greatest area—fifteen thousand miles by eleven thousand miles. From the 1st until the 7th, the inner edge of the penumbra appeared to be fringed more brightly, and on the 7th and 8th, the bright photospheric substance broke through the penumbra on the southern side. On the 10th, the place of the spot was marked by three closely packed umbrae which had disappeared by next day, the site being marked by faculae seen also on the 12th. On the 2nd the three more distant spotlets had broken into one with a long umbra, which again broke up very quickly. The pores were subject to rapid change. On the 4th, 6th and 7th, a little pilot pore was evident just west of the leader, and on the 6th and 8th, pores showed a little towards the south. The maximum length was fifty-six thousand miles. On the 2nd a faculic knot showed just ahead of the group in which pores appeared to be developing, but it disappeared again. The group sometimes presented a very interesting appearance in the spectroscope. On the 1st the H_a line showed displacements both on the red and violet sides, with dull reversals, whilst the D_3 line of helium was seen dark. Next day the distortion was less, but small dark hydrogen flocculi were visible around, as well as small projected prominences. On the 5th a pale prominence in the rear of the leader was visible, and also small dark hydrogen flocculi, with the helium line showing dusky.

The dotted areas in the diagram show the position of faculic disturbances. Faculae were seen on the 1st and 2nd near longitude 256°, N. latitude 50°, and 26°, N. 33°. On the 1st, 2nd and 12th near 260°, S. 13°. On the 4th and 5th, at 225°, S. 3°; another at 215°, S. 15°, on 4th, with another at 202°, S. 4°, on 5th and 6th. The group at 320°—340°, S. 13°—20° were visible September 22nd to 24th.

Notwithstanding the fewness of disturbances visually seen upon the disc, there are still a fair number of prominences around the limb. On the 24th there were a number of eruptions recorded showing that the chromosphere was in a very active condition.

The Chart is constructed from the observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and F. C. Dennett.

DAY OF SEPTEMBER, 1911.



NOTICES.

MUSEUM WORK.—Particulars of a vacancy for a pupil (who will be paid a small salary) in a museum, can be obtained on application to the Editors of "KNOWLEDGE," at 42, Bloomsbury Square, London, W.C.

CHEMICAL APPARATUS.—We have received from Messrs. Gallenkamp and Company, Limited, Part 1 of their catalogue of General Chemical Apparatus and Laboratory Accessories for the Session 1911-12. It measures seven by eleven inches and consists of more than eight hundred pages. Messrs. Gallenkamp claim to have the most varied stock in England, and their price list is certainly excellent evidence in favour of this contention.

HORTICULTURAL BOOKS.—Messrs. John Weldon & Company's Catalogue of Gardening Books and Papers, which has just reached us, contains no less than one thousand and eighty-five items and should prove exceedingly interesting to all who are occupied in the art which we are told "doth mend nature."

From a photograph by G. B. Hony.

A Gibraltar Ape.

BARBARY APES AT GIBRALTAR.—In *The Selborne Magazine* for November, Mr. G. B. Hony gives the following account of the Apes of Gibraltar. He says :—" At the present time there are only eleven apes on the rock, eight females and three males. Of these only three are of the original Gibraltar stock. The remainder have been imported from various parts of Africa, and there are altogether specimens of four distinct races. They have not bred on the rock for years, but fresh stock having been imported, it is hoped that there will soon be some 'home-bred' ones. The first time I saw them there were six together; they were very shy, and my repeated efforts to get photographs failed." Afterwards Mr. Hony succeeded, and one of his pictures is here reproduced.